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FOREWORD

Readers will notice that the *Journal* contains a fair proportion of matter that is not original. This is mainly due to the sudden falling off of original contributions and, to a lesser extent, to our desire to reprint certain excellent articles which have appeared elsewhere. At a later date than might have been expected, diversion from ordinary investigational work and preoccupation with immediate war problems that cannot be written about, have combined to reduce contributions sharply.

We know that many will agree with us that the *Journal*, even as a quarterly, performs a really useful function in East Africa. Looking through the past numbers we are astonished to see how great a storehouse they are of information and of suggestion useful to those concerned in any way with tropical agriculture. With the increasing awareness in the world that agriculture must not, and cannot without disaster, be run by methods of trial and error, it is certain that responsible publications on the subject will tend to become of more importance than in the past, not less. East African problems are peculiar to East Africa: work and discussion elsewhere can help with their solution but cannot replace what we do and think and write ourselves.

In present stress it is becoming more and more difficult for most of us to achieve the time and the mood in which to write for the *Journal*, however much material we have. Nevertheless we do appeal to our friends, both unofficial and official, to supply the *Journal* with the contributions without which it must cease publication. Suggestions for reprints and of subjects that might usefully be dealt with in the *Journal* would be equally acceptable.

Agriculturists are flexible in outlook and accustomed to having their old and cherished theories upset by new knowledge based on recent research. It will therefore come as no surprise to learn that two of our oldest theories must now be modified or even cast aside. These concern the part played by goats in soil erosion, and the unsuitability of rice as a crop for dry country. We publish in this number articles on these two subjects.

The first of these articles is a study of the comparative effect of goats and cattle on a mixed bush–grass pasture and goes to show that the goat is not the universal destroyer that it is generally said to be, but instead a means of improving certain types of "bush-land" and a potential source of much-needed animal produce in such areas. The author concludes, "the current idea that the goat is a pernicious animal of which the numbers must be reduced is quite wrong when one is considering the economics of bush-land utilization. In fact, if one desires to obtain animal produce from this type of country without first cleaning it and putting it down to grass, the only way in which the attempt can safely be made is by making use of goats". If the author's findings are confirmed in other areas they must lead to a complete re-orientation of our views on the goat and will, we hope, in time result in this animal taking its proper place in animal husbandry, particularly as a milk producer. If the nutrition of the African is to be put on a proper basis it is essential that more milk should be introduced into his family diet. The obvious way of doing this would seem to be through the improvement of the hardy goat by selective breeding and correct management. For various reasons it must be many years before the bulk of African farmers can become cattle owners, but a large proportion of them already keep goats which, if improved in breed and controlled in numbers, might safely be made to serve as an abundant source of animal produce, even in some of our tsetse-infected areas.

Finally, Mr. Allnutt shows with what astonishing success rice is being grown with only a low rainfall, badly distributed, and no other supply of water. Moreover, rice cultivation by the methods he describes involves soil conservation works of great and permanent value.

A STUDY OF THE COMPARATIVE EFFECTS OF GOATS AND CATTLE ON A MIXED GRASS-BUSH PASTURE

By R. R. Staples, H. E. Hornby and Robina M. Hornby, from the Veterinary Laboratory, Mpwapwa

In an article on "Overstocking in Tanganyika Territory", Hornby (1936) incidentally defended the goat against the oft-expressed charge that this "pernicious" animal is a main cause of soil erosion in East Africa. He wrote: "The goat is often referred to as though its depredations exceeded those of other animals. I think the reason for this is that this species is more injurious to trees than are cattle and sheep, and that it bears the double blame of destroying both forests and land. This is not quite fair. Leaving on one side the small areas of evergreen forest in process of spoliation, and turning to the infinitely greater areas of dry forest and open woodland which are being ruined, we find that the goat plays an unimportant part in promoting soil erosion until towards the last stages. So long as there are bushes and herbs on which to browse he nibbles contentedly at these and leaves the grass almost alone. He prunes and stunts the bushes, and thus actually encourages grass growth, in short he does if anything less than his share to *initiate* erosion. This is done by too close grazing by cattle and sheep and by the destruction of vegetation by excessive tramping. After a time when, in conjunction with faulty methods of agriculture, the cattle and sheep have created a wilderness of gullies separated by dry ridges bearing nothing in the way of vegetation but the hardiest of shrubs, then, when the cattle and sheep have departed with the last of the grass, the goat is still to be found, and as he valiantly extracts a livelihood where no other animal can live he undoubtedly makes yet steeper the sides of gullies, and appears to be doing his best to remove the last of the plants and with them the last of the soil. But, in reality, he is merely completing the destruction wrought by sheep, cattle, donkeys and man."

Naturally, a mere assertion of this nature carries little weight; therefore, when in the course of animal husbandry studies at Mpwapwa, the Veterinary Department formed the opinion that more and better use should be made of goats in bushland, it was decided that a simple enclosure experiment to demonstrate the comparative effects of goats and cattle on a mixed grass-bushland pasture should be staged. The experiment started in January, 1938, and now, after more than four years, the results are sufficiently clear-cut to justify description.

Experimental Area

This is the same as that used by Staples (1935) for his "Soil Moisture Determinations in Thicket and Adjacent Grassland". For the benefit of those to whom this article is not available we may say that the area is one of Deciduous Bushland on deep sandy loam, at an altitude of about 3,500 feet.

The Experimental Pasture

We selected a piece of land that, two or three years earlier, had been cleared from climax bush by cutting, burning the trash and planting the burnt patches with *Cynodon plectostachyum* Pilg. This had been protected from over-grazing, and some mattocking had been done. The result was a good stand of grasses mixed with herbs and regenerating, though still inconspicuous, woody plants; a useful pasture tending to revert to bush.

Experimental Lay-out

Five plots, each 35 yd. × 35 yd., i.e. approximately one-quarter of an acre, were laid out in a line along a contour. They showed a farily uniform type of vegetation, and a further safeguard was the arrangement whereby plots 1 and 5 were to be grazed by cattle, 2 & 4 by goats, while the middle, No. 3, was to be an untouched control. They were fenced; the goat plots with wire netting in addition to barbed wire.

Animals and Grazing Days.—In the opinion of Dr. M. H. French, the Veterinary Department's Chemist, an average zebu ox eats about seven times as much as an average native goat. A single ox will rarely stay quietly by itself, so into each pastured plot either two oxen or about 14 goats were put on one or two days a week whenever there was enough food to keep them all reasonably contented. If one plot became too bare for use, grazing of all was discontinued until all were ready again.

The experiment started on 8th January, 1938, and from then until now (March, 1942) two oxen and 14 goats have been pastured intermittently on each pair of plots throughout the first seven or eight months of each year. No importance is attached to the actual number of

grazing days, which is 30 to 40 per annum, since the animals slept and were watered away from the plots and thus got a good deal of food outside, even on plot-grazing days. However, the number of hours of occupation by animals is the same for all plots, and the effect on the herbage is probably the same as if the animals had put in from 15 to 25 *full* grazing days per annum, i.e. at the rate of one ox or seven goats to two or three acres. From the start of the experiment, no interference with the vegetation other than that by the animals was permitted.

Changes in the Vegetation

We made the mistake of not recording details of each plot before grazing commenced, though as the area had recently been mattocked, there was little beyond *Cynodon* grass to be seen. The first careful examination was made in July, 1938, after the plots had been occupied on more than 20 days, and considerable changes effected by grazing, browsing and tramping, as well as by seasonal disappearance of annual grasses and herbs. Thus the great increase in the length of the 1942 list of plants over that of 1938 is due mainly to reappearance of many woody plants after "clearing", but partly to the more profuse aspect of the later reconnaissances.

Examination by quadrat methods was not attempted, but the plots were kept under close observation, and a comparison of the notes obtained recently with those written nearly four years ago can be epitomized in the form of a table, and then discussed.

Of the various divisions of the table, one can dismiss "(1) *Trees over* 12 *ft.*" with little comment. The practice of pasture making at Mpwapwa includes the leaving of occasional shade trees, and everything over 12 ft. present in 1942 was present as a small shade tree in 1938. Of the regenerating trees and shrubs nothing had grown higher than 12 ft. in four years.

"(2) *Trees and Shrubs from* 6 *to* 12 *ft. high*".—As stated earlier, the plots had been mattocked shortly before the experiment started, and no woody plants except the few in division (1) had been spared. Only the 1942 columns need be studied, but these show important differences: (*a*) The goat plots are represented by only two species; in fact by a single candelabra euphorbia and half a dozen *Lasiosiphon emini*. (*b*) The ox plots are well represented, but are beaten by the control. These figures confirm what is readily apparent to the eye: the sparseness of well-grown woody plants in the goat plots; their frequence in the other plots, particularly in the control.

"(3) *Trees and Shrubs, from* 2 *to* 6 *ft. high*".—In this division, figures suggest little difference, in 1942, between the ox plots and goat plots—44 species in the one, and 41 in the other—but considerable difference between these and the control, with 16 species. However, this is not a clear indication of what the eye sees, since the average height of the plants of this division in the goat plots is less than 4 ft., and considerably lower than that of their opposite numbers in the ox plots. The poor representation of this division in the control plot is due to better growth of many plants permitting their promotion to division (2).

"(4) *Scandent and Trailing Plants*".—Many of the species of this division are inconspicuous and more readily observed in the open thicket of the ox plants than in the closer vegetation tangles of the other plots. Therefore, the differences in the numbers of species noted recently—22 in the ox plots, 19 in the goat plots and 11 in the control—probably lack significance.

"(5) and (7) *Herbs and Monocotyledons other than Grasses*".—No significant differences between the plots are to be noted, either from the figures of the table, or from direct inspection. Certain species, *Rhinacanthus communis, Solanum panduriforme* and, notably, *Wedelia menotriche*, are important elements in every plot at all seasons, while others have brief seasonal importance. No species was picked out as indicating the special effects of any one form of treatment.

"(6) *Grasses*".—One species, *Sorghum versicolor*, formerly present in the control plot, appears to have died out,* and the annual *Eragrostis* and *Aristida* seen in the goat plots in 1938 are no longer in evidence. Also, there are small stands of *Chloris myriostachya* and a sprinkling of *Enteropogon machrostachyum* in the goat plots that are not present elsewhere. However, we do not think any importance should be attached to these small differences, which, after all, may be aspectional. The significant differences are quantitative rather than qualitative: viewed recently, the goat plots showed good grass cover, chiefly of *Cynodon*; the control had a good cover of mixed grasses in the still open spaces between the bushes, whereas the ox plots had a poor ground cover, and much bare soil was visible. These differences will be referred to again.

* This would have been expected, since the species is a pioneer short-lived perennial.—*P.J.G.*

PLANTS OF THE EXPERIMENTAL PLOTS

	Whether Noted as Present (P)					
	Pts. 1 and 5 (Oxen)		Pts. 2 and 4 (Goats)		Control	
	1938	1942	1938	1942	1938	1942
(1) Trees Over 12 Feet—						
Acacia spirocarpa Hochst.	—	—	—	—	P	P
Albizzia anthelmintica Brongn.	—	—	—	—	P	P
A. brachycalyx Oliv.	P	P	—	—	—	—
A. harveyi Fourn.	—	—	—	—	P	P
Euphorbia bilocularis N.E. Br.	—	—	P	P	—	—
Hippocratea buchananii Loes.	—	—	P	P	—	—
Zizyphus mucronata Willd.	P	P	—	—	—	—
(2) Young or Coppiced Trees and Shrubs, 6 to 12 Ft.						
Acacia benthamii Rochebr.	—	P	—	—	—	—
A. kinionge De Wild	—	P	—	—	—	—
A. spirocarpa Hochst.	—	P	—	—	—	—
Acalypha fruticosa Forsk.	—	—	—	—	—	P
Adansonia digitata L.	—	—	—	—	—	P
Albizzia brachycalyx Oliv.	—	—	—	—	—	P
A. harveyi Fourn.	—	—	—	—	—	P
Allophylus rubrifolius Hochst.	—	—	—	—	—	P
Boscia grandifolia Gilg	—	—	—	—	—	P
Canthium huillense Hiern.	—	P	—	—	—	P
Cassia abbreviata Oliv.	—	P	—	—	—	P
C. singueana Del.	—	P	—	—	—	P
Cissus cornifolia Planch.	—	—	—	—	—	P
Clerodendron scheffleri Gurke	—	—	—	—	—	P
Commiphora lindensis Engl.	—	P	—	—	—	P
C. pilosa Engl.	—	P	—	—	—	P
Cordia ovalis R. Br.	—	P	—	—	—	P
Courbonia edulis Gilg & Ben.	—	—	—	—	—	P
Crotalaria saxatilis Vatke	—	—	—	—	—	P
Dichrostachys glomerata Chiov.	—	—	—	—	—	P
Diospyros sp. (Hby. 524)	—	—	—	—	—	P
Dombeya sp.	—	P	—	—	—	—
Ehretia coerulea Gurke	—	—	—	—	—	P
Elaedendron stuhlmannii Loes	—	P	—	—	—	P
Euphorbia bilocularis N.E. Br.	—	—	—	P	—	—
Fagara chalybea Engl.	—	P	—	—	—	—
Grewia bicolor Juss.	—	P	—	—	—	P
G. platyclada K. Schum.	—	P	—	—	—	P
Grewia sp. nr. *G. similis* K. Schum.	—	P	—	—	—	P
Hippocratea buchananii Loes.	—	P	—	—	—	P
Hoslundia opposita Vahl	—	—	—	—	—	P
Lannea humilis Engl.	—	—	—	—	—	P
Lasiosiphon emini Engl. & Gilg	—	—	—	P	—	P
Lonchocarpus fischeri Harms	—	—	—	—	—	P
Maerua cylindricarpa Gilg & Ben.	—	P	—	—	—	—
Markhamia acuminata K. Schum.	—	P	—	—	—	P
Ormocarpum kirkii S. Moore	—	P	—	—	—	P
Phyllanthus discoideus Mull. & Arg.	—	P	—	—	—	—
Premna holstii Gurke	—	P	—	—	—	P
Rhus incana Mill.	—	P	—	—	—	—
Strychnos heterodoxa Gilg	—	—	—	—	—	P
Thylachium africanum Lour.	—	P	—	—	—	P
Vangueria acutiloba Robyns	—	P	—	—	—	—
Vitex sp. (Hby. 153)	—	P	—	—	—	P
Zizyphus mucronata Willd.	—	P	—	—	—	—
(3) Young or Coppiced Trees and Shrubs, 2 to 6 Ft.						
Acacia benthamii Rochebr.	—	P	—	—	—	—
A. kinionge De Wild.	P	P	—	—	—	P
A. spirocarpa Hochst.	P	P	—	P	—	—
Acalypha fruticosa Forsk.	—	P	—	P	—	—
Adansonia digitata L.	—	P	—	—	—	—
Albizzia anthelmintica Brongn.	—	P	—	—	—	—
A Harveyi Fourn	—	—	—	P	P	—
Allophylus rubrifolius Hochst.	—	P	P	P	P	—
Berchema discolor Hemsl.	—	—	—	P	—	—
Boscia grandifiora Gilg	P	P	P	P	—	—
Capparis kirkii Oliv.	—	P	—	—	—	—
Cassia abbreviata Oliv.	—	—	—	P	—	—
C. singueana Del.	P	P	—	P	P	—
Cissus cornifolia Planch.	—	P	—	P	—	—

PLANTS OF THE EXPERIMENTAL PLOTS

	Whether Noted as Present (P)					
	Pts. 1 and 5 (Oxen)		Pts. 2 and 4 (Goats)		Control	
	1938	1942	1938	1942	1938	1942
Clerodendron scheffleri Gurke	—	P	—	P	—	—
Commiphora boiviniana Engl.	—	P	—	—	—	—
C. lindensis Engl.	—	P	—	P	—	P
C. pilosa Engl.	—	P	—	P	—	P
Cordia ovalis R. Br.	P	P	—	P	P	—
Courbonia edulis Gilg & Ben.	P	P	P	P	P	P
Crotalaria saxatilis Vatke	P	P	—	P	P	P
Croton menyharti Pax	—	—	—	—	P	—
Dichrostachys glomerata Chiov.	—	P	—	P	—	—
Diospyros sp. (Hby. 524)	—	P	—	—	P	—
Disperma crenatum Milne-Redhead	—	P	—	—	P	P
Ehretia coerulea Gurke	—	P	—	P	P	P
Elaeodendron stuhlmannii Loes.	P	P	P	P	—	—
Erythrococca atrovirens Prain	—	P	—	P	—	—
Fluggea virosa Baill.	—	—	—	P	—	—
Grewia bicolor Juss.	P	P	P	P	P	—
G. platyclada K. Schum.	P	P	P	P	P	P
Grewia sp. nr. *G. similis* K. Schum.	P	P	P	P	P	—
Hibiscus micranthus L.	—	P	P	P	—	—
Hippocratea buchananii Loes.	—	—	—	P	—	P
Hoslundia opposita Vahl	P	P	P	P	P	P
Lannea humilis Engl.	—	—	—	—	—	P
Lannea stuhlmannii Engl.	—	P	—	—	—	—
Lantana salviifolia Jacq.	P	P	—	P	P	P
Lasiosiphon emini Engl. & Gilg	P	P	P	P	—	—
Lonchocarpus capassa Rolfe	—	—	—	P	—	—
L. fischeri Harms	P	P	—	P	—	—
Maerua angolensis D.C.	—	P	—	P	P	—
M. cylindricarpa Gilg & Ben.	—	—	—	P	—	—
Markhamia acuminata K. Schum.	—	—	—	P	P	P
Marsdenia umbellifera K. Schum.	—	P	—	P	—	—
Opilia campestris Engl.	—	P	—	—	P	—
Ormocarpum kirkii S. Moore	P	P	P	P	P	P
Pavetta dolicantha Brem.	—	P	—	P	—	P
Premna holstii Gurke	P	—	—	P	P	—
Phyllanthus discoideus Mull. & Arg.	P	P	—	—	—	—
Randia sp. (Hby. 168)	—	P	—	—	—	—
Rhus incana Mill.	P	—	—	—	P	—
Steganotaenia araliacea Hochst.	—	—	—	—	P	—
Sterculia africana Fiori	—	P	—	—	—	—
Thespesia garckeana F. Hoffm.	—	P	—	—	—	—
Thylachium africanum Lour.	P	—	—	P	—	—
Vangueria acutiloba Robyns	P	—	—	—	—	—
Vitex sp. (Hby. 153)	P	P	—	P	P	P
Ximenia caffra Sond.	P	P	—	P	—	—
Zizyphus mucronata Willd.	P	—	—	P	—	—
(4) Scandent and Trailing Plants—						
Acacia pennata Willd.	P	P	P	P	P	P
Adenia sp. (Hby. 551)	—	—	—	P	—	—
Ampelocissus grantii Planch.	—	—	—	P	—	P
Asparagus sp.	—	P	—	—	—	—
Bauhinia fassoglensis Kotschy	—	P	—	—	—	—
Blepharis hornbyae Milne-Redhead	P	—	P	P	P	P
Cadaba adenotricha Gilg & Ben.	—	P	P	P	—	P
Capparis tomentosa Lam.	P	P	—	—	—	—
Caucanthus auricularis Nied.	—	P	—	—	—	—
Cissampelos pareira L.	P	—	—	—	—	—
Cissus oliveri Gilg	—	P	—	—	—	—
Cissus sp. (Hby. 171)	—	P	—	P	—	—
Coccinia palmata Cogn.	—	P	—	P	—	—
Combretum longispicatum Engl.	—	—	—	P	—	P
C. purpureiflorum Engl.	P	—	P	P	P	—
Dalbergia fischeri Taub.	P	P	P	—	—	P
Entada flexuosa Hutch & Dalz.	—	P	—	—	—	—
Helinus ovatus E. Mey	—	P	—	P	P	P
Hippocratea loesneriana Hutch & M. B. Moss	—	—	—	—	—	P
Jasminum kagoji Gilg	—	P	—	P	—	P
Marsdenia zambesiaca Schltr.	P	P	P	P	P	P
Psychotria hirtella Oliv.	—	—	—	P	—	—

PLANTS OF THE EXPERIMENTAL PLOTS

	Whether Noted as Present (P)					
	Pts. 1 and 5 (Oxen)		Pts. 2 and 4 (Goats)		Control	
	1938	1942	1938	1942	1938	1942
Pupalia lappacea Juss.	—	P	—	P	—	—
Rhynchosia flavissima Hochst.	—	P	—	—	—	—
Secamone floribunda N.E. Br.	P	P	—	P	P	P
Tephrosia purpurea Pers.	—	P	—	—	—	—
Tragia benthamii Baker	—	P	P	P	—	—
Triaspis macropteron var. *speciosa* Nied.	—	P	—	P	—	—
Vigna nilotica Hook. f.	—	P	P	P	—	—
V. vexillata Benth.	—	P	P	P	—	—
(5) Herbs—						
Acalypha ciliata Forsk.	—	—	—	—	—	P
Achyranthes aspera L.	—	—	—	P	P	—
Astrochlaena hyoscamoides Hallier	—	P	—	—	P	P
Barleria ventricosa Nees	P	P	P	P	—	—
Bidens pilosa L.	—	—	—	—	P	—
Cassia tora L.	—	P	—	P	—	P
Celosia schweinfurthiana Schinz	—	—	—	P	—	—
Crabbea sp. (Hby. 506)=*C. hirsuta*?	—	P	—	—	—	—
Crotalaria cylindrostachys Welw.	—	—	—	P	—	P
C. quartiniana Rich.	—	P	—	—	—	P
Dyschoriste trichocalyx Lindau	—	—	P	P	P	—
Hermannia exappendiculata K. Sch.	P	P	P	P	—	—
H. viscosa Hiern	—	—	P	—	—	—
Hibiscus=*H. Marstersianus* Hiern	—	—	—	P	—	P
H. solandra d'Her.	—	—	—	P	—	—
H. vitifolius L.	—	P	—	P	—	P
Indigofera arrecta Hochst.	P	P	—	P	—	—
I. retroflexa Baill.	—	P	—	P	—	P
Justicia betonica L.	P	—	—	—	P	—
J. heterocarpa T. And.	P	—	P	—	—	—
Justicia sp. (Hby. 188)	—	—	—	—	—	P
Leucas martinicensis R. Br.	P	P	P	—	—	—
Melhania ferruginea A. Rich.	—	P	—	P	—	P
Monechma bracteatum Hochst.	P	—	P	—	P	—
Ocimum americanum L.	P	—	—	—	—	—
Ocimum sp. nr. *O. suave* Willd.	—	P	P	P	—	—
Peristrophe bicalyculata Nees	—	—	—	—	P	—
Rhinacanthus communis Nees	P	P	P	P	P	P
Sida grewoides Guill. & Pers.	P	P	P	—	—	—
Solanum panduriforme E. Mey.	P	P	P	P	P	P
Spermacoce ruelliae D.C.	—	P	—	—	—	—
Tephrosia incana Graham	—	P	—	—	—	—
Triumfetta pentandra A. Rich.	—	P	—	P	—	P
Waltheria americanum L.	—	—	P	—	—	—
Wedelia menotriche Oliv. & Hiern	P	P	P	P	P	P
(6) Grasses—						
Alloteropsis cimicina Stapf	—	P	—	P	—	—
Aristida adscensionis L.	—	—	P	—	—	—
Bothriochloa insculpta A. Camus	—	P	—	P	P	P
Brachiaria regularis Stapf	—	P	—	P	—	P
B. serrifolia Stapf	—	P	—	P	—	P
Chloris myriostachya Hochst.	—	—	P	P	—	—
Cynodon plectostachyum Pilg.	P	P	P	P	P	P
Digitaria gazensis Rendle	—	P	—	P	—	—
Enteropogon macrostachyum Munro	—	—	—	P	—	—
Eragrostis aspera Nees	—	—	P	—	—	—
Heteropogon contortus Roem. & Schultz	P	P	P	P	P	P
Hyparrhenia sp.	—	—	—	—	P	—
Panicum maximum Jacq.	—	P	P	P	P	P
Panicum sp. (Hby. 211)	—	—	—	P	—	P
Setaria homonyma Chiov.	—	—	—	P	—	—
S. pallidifusca P. Beauv.	—	P	—	P	—	P
Sorghum versicolor Anders.	—	—	—	—	P	—
Sporobolus sp. (Staples 206)	—	P	—	P	—	—
Tragus racemosus All.	—	P	—	—	—	—
Urochloa trichopus Stapf	—	P	—	P	—	—
(7) Other Monocotyledons—						
Chlorophytum sp. (Hby. 631)	—	P	—	P	—	P
Commelina sp.	—	P	—	P	—	P
Gloriosa viriscens Lindl.	—	—	—	P	—	P
Kaempfera sp.	—	P	—	P	—	P
Scilla kirkii Baker	—	—	—	P	—	—
Tulbaghia cameroni Baker	—	P	—	P	—	P

Inspection Notes

It is clear from the table that few, if any, species have been actually eradicated during four years as the result of heavy utilization by stock. But that a profound modification of the plant communities has nevertheless been effected is indicated by division (2) of the table, and is clear from simple inspection of the plots themselves.

Between 16th and 18th December, 1941, just before the opening of the present grazing season, the following notes were made:—

"The rains commenced unusually early, a month ago. Trees and shrubs are in almost full leaf, and there has been good growth of perennial grasses. Seedlings of annuals, though, have had insufficient rain and show temporary wilting. No animals have fed on the plots since last July.

Plot 1 (*Cattle*) (See Fig. 1).—Dominating the plot is a *Zizyphus mucronata*, 25 ft. high and 10 yards across, with some grass growing below. There is a second *Z. mucronata* that, with *Commiphora pilosa* and *Phyllanthus discoideus*, forms a thicket clump, 12 ft. high and 4 yards in diameter. Much bare ground is visible in spite of fair growth of *Cynodon plectostachyum* and of the less vigorous perennials, *Heteropogon contortus* and *Bothriocholoa insculpta*. Seedlings of annual grasses and herbs (notably *Cassia tora*) as yet contribute little to the protection of the ground, and there are not many liliaceous plants. The plot is open thicket, 4 to 12 ft. high, tending to close in its lowest third: with poor grazing and bare ground that invites erosion.

Plot 2 (*Goats*).—Contrasting with the open thicket of Plot 1, the vegetation of Plot 2 is a mixture of grasses and browsed bushes forming a fairly uniform close cover, 2 to 5 ft. high. A single *Euphorbia bilocularis* is the only tree in the plot, though the bottom left-hand corner is shaded by an *Acacia spirocarpa* in the adjoining Plot 3. Only in the bottom right-hand corner does thicket predominate over grasses; although still low, there is a tangle of woody plants around one or two large *Combretum purpureiflorum*. Elsewhere the mixture of plants contains a large percentage of grasses, notably *Cynodon*, with some *Heteropogon contortus, Enteropogon macrostachyum, Panicum maximum* and seedlings of annuals. This grass cover includes a good deal of the unconsumed and decaying growth of last season. Helping to cover the ground are several liliaceous plants.

Plot 3 (*Control*).—Beneath the more shady bushes the ground is almost bare. Between these larger species much of the ground is occupied by low-growing shrubs, like *Lantana salviifolia, Blepharis hornbyae* and *Wedelia menotriche* (of which, last year's dry stalks persist), and there are some liliaceous plants. In the more open spaces *Cynodon plectostachyum* forms a good protection with its mixture of old and new shoots. There is a large colony of *Heteropogon contortus* in the middle of the plot, and in the bottom right-hand corner, beneath the shade of the *Acacia spirocarpa* and a *Dalbergia*, is a colony of *Panicum maximum*: a mixture of old and new growth reaching to a height of 6 ft. Seedling grasses of unidentified species help to cover the soil, so that there appears to be little danger of erosion. This plot shows a stage of bushland succession in advance of the other plots. The general impression is of a closing but still fairly open thicket with considerable grass cover.

Plot 4 (*Goats*) (See Fig. 2).—This plot presents an amazingly level surface of vegetation. The only plants more than 4 or 5 ft. high (i.e. that have got away from the goats) are an *Euphorbia bilocularis* (8 ft.), a *Hippocratea buchananii* (12 ft.), a few *Lasiosiphon emini* (8 ft.), an *Acacia pennata* (9 ft.) and some *Hibiscus micranthus* (6 ft.). However, the remaining woody plants, though checked, are vigorous. The grassy constituents of most of the plot are almost exclusively *Cynodon*, of which the plants close right in on the numerous *Wedelia, Courbonia* and other low shrubs. Whether the low stature of all these is due to browsing alone is not certain; grass competition may play a part. In the lower left-hand corner, however, woody growth is more vigorous: *Combretum purpureiflorum* and more numerous *Lantana salviifolia* inhibiting grass growth, though even away from these shrubs the grasses are weak and bare ground is visible. In this part *Panicum maximum, Heteropogon contortus* and *Bothriochloa insculpta* are the prevailing perennials. The annual grasses are not yet recognizable. The general appearance of Plot 4 is of weedy grassland.

Plot 5 (*Cattle*).—This plot presents an appearance of open thicket of shrubs and coppicing trees, 4 to 10 ft. high. There is a single *Albizzia brachycalyx*, 25 ft. high. About half the ground is covered by bushes; about one-quarter is either utterly bare or with scattered seedlings of grasses, shrubs (notably *Ehretia coerulea*) and herbs (notably *Solanum*

FIG. 1.—Plot 1 (Cattle) on 27/11/41. The large bushes are *Zizyphus mucronata*. In front of the post are dry sticks of *Wedelia menotriche*. There is sparse ground cover of young *Cynodon*, with bushes of *Wedelia* and *Courbonia edulis*.

FIG. 2.—Plot 4 (Goats) on 27/11/42. A good ground cover of *Cynodon*, with little bushes of *Lantana salviifolia*, *Ehretia coerulea* and *Vitex sp.* The flowering bush behind the post is *Hibiscus micranthus*.

panduriforme), while the remaining quarter is fairly well covered by recent growth of *Cynodon*, *Heteropogon* and *Bothriochloa*, together with seedling grasses and herbs."

When the above observations had been completed, the plots were thrown open for the present (1941-1942) season's grazing. Throughout January, 1942, rains were good, and grass growth was more than equal to the demands of two days' grazing each week. On the other hand, the whole of February and the first week of March were dry and during this period grass growth stopped, bushes began to look autumnal, and, on packed soil, grasses and herbs wilted. At the beginning of March the ox plots were so eaten down that further grazing of all plots was postponed until fresh rains—that commenced on 9th March—had revived the herbage.

Palatability.—Throughout January and February a number of observations were made regarding preferences and rejections of plants by the two kinds of animals. Details need not be given, but the following notes, made at the beginning of March, summarize the observations:—

"*Plot* 1 (*Cattle*).—The only species of woody plant that has been browsed freely is *Acalypha ornata*. One or two plants of *Crotalaria saxatilis* and *Grewia platyclada* have been eaten without relish, and a number of trees and shrubs of other species have been picked at occasionally. It is quite clear, though, that the feed furnished by these plants has been negligible compared with that furnished by grasses together with a few herbs which, if mixed up with stands of grasses, are eaten, but if standing apart are usually left alone. All grasses listed in the table have been eaten down; what little grazing remains is almost exclusively *Cynodon*, and few annuals have been permitted to seed. There is much bare ground subject to erosion, and the plot is typical of the less greviously exploited bush grazings of Ugogo—an example of the kind of land abuse which must be sternly deprecated.

Plot 2 (*Goats*).—In this plot only Cassias and *Pavetta dolicantha* are species definitely unpalatable and rarely, if ever, eaten. It is true that a small *Lonchocarpus capassa* and one or two *Cordia ovalis*, both species with rough leaves, also *Courbonia edulis* (leafless at this season) have escaped recent attention by the goats, but one knows that these species are not always unpalatable, and in former years some of these particular plants have been eaten back. Almost all other plants, including grasses, have been eaten more or less readily and to a large extent in proportion to their height. For goats like to feed with their heads well away from the ground, and they browse almost indiscriminately on anything that is head high; preferring also to stretch upwards than to reach down. One result is that the tall grass *Panicum maximum* and the growing tips of *Cynodon*, which are well off the ground, have been eaten freely, while short annual grasses have been neglected and are now seeding. The tangle of *Combretum purpureiflorum* mentioned as prominent at the beginning of the season has been stripped of most of its leaves and much broken up. The general effect throughout the plot of the goats' activities is a somewhat tramped but still considerable vegetative ground cover composed of many species of plants, but with grasses, notably *Cynodon*, predominating. At this time, when the ox plots are grazed out, there is still plenty of feed—for cattle as well as for goats—in the goat plots.

Plot 3 (*Control*).—The general appearance has changed little since this was described in December. The ground cover, though, is considerably better now than then owing to the growth of annual grasses and herbs. In general terms one may describe the plot as dominated by three or four trees, 20 to 25 ft. high, below which is a discontinuous bush storey, 5 to 12 ft. high, and below this again is a still good ground cover of grasses and herbs.

Plots 4 and 5 so closely resemble their counterparts 2 and 1 that description of them is unnecessary."

Discussion

General observation gives the impression that when sufficient goats are pastured on grassland that contains many kinds of regenerating bushes, most of these are kept browsed down to a height of three or four feet, while the grasses escape much attention. More detailed examination, however, shows that in reality tall grasses are eaten as freely as bushes, though, unless stocking is very heavy, the attacks on both kinds of plants are largely restricted to portions well away from the ground. This is due to the goat's preference for browsing to grazing. Therefore, under the conditions of our experiment, short annual grasses and herbs receive little attention from goats, while the taller plants are kept browsed down—but not to the ground, and consequently they are not destroyed. Rather surprisingly, goats do little damage to the bark of

well-grown trees of the bushland, so young trees of this formation which succeed in putting out branches beyond the reach of goats are usually safe from further molestation. Not all bushes are of equal palatability, and a few are consistently rejected, but the growth of these is inhibited by competition with the other species, which though eaten still remain vigorous. The net result of such stocking is to preserve a good ground cover consisting of many kinds of plants kept to a low level. This tangle is too low to support tsetse, and yet is an adequate protector of the soil; indeed it would appear to be difficult to crowd goats on to unfenced grassy bushland in such high concentration that they bare the ground sufficiently to initiate serious erosion.

By contrast, the effect of pasturing cattle on grassy bushland is invariably bad. By concentrating on the grasses they relieve the bushes from competition, and though the advantages (to the bushes) of this is more than offset by packing of the soil through tramping, the unrelieved tendency is towards the formation of open thicket with little ground cover; obviously a condition of continuous reduction of carrying capacity and of accelerated erosion, until the appalling state of affairs seen around Dodoma, Kondoa–Irangi and Singida is reached. In the neighbourhood of fly-belts, such open thicket permeated by cattle often results from neglect of "tsetse clearings", and is followed by return of the fly to an area now denuded of some fertility; a state that is worse than the one before the clearing was made.

The main clear-cut conclusion from this experiment is that wherever in bushland country there is some sort of ground cover of grasses and herbs which can be expected to extend if given a chance, such an area will not be damaged but may be much improved by even heavy goat browsing, whereas certainly it would be damaged by anything more than the lightest grazing by cattle. The current idea that the goat is a pernicious animal, of which the numbers must everywhere be reduced if the land is to be saved, is quite wrong when one is considering the economics of bushland utilization. In fact, if one desires to obtain animal produce from this type of country without first clearing it and putting it down to grass, the only way in which the attempt can safely be made is by making use of goats.

At the instigation of the present Director of Veterinary Services, this investigation is about to be taken a step further. A field experiment has been planned to ascertain if goats can with advantage be introduced into "chess-board" rotational grazing schemes designed primarily for cattle.

Summary

A description is given of a simple enclosure experiment to demonstrate comparative effects of goats and cattle on a pasture obtained by clearing bushland and planting *Cynodon* grass; a pasture that tends always to revert to bush.

After four years of heavy but controlled utilization, great differences are apparent between the plots grazed exclusively by cattle and those fed on only by goats. The cattle plots have become open thicket, with poor grazing, bare ground that invites erosion, and cover sufficient for the needs of tsetse flies. The goat plots are still grassland which, though full of weeds, constitutes good grazing for any kind of stock; there is little bare ground, and the cover is too low to support tsetse.

Conclusions derived from the experiment are discussed.

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PROSPECTS FOR SOIL CONSERVATION*

By G. V. Jacks, Deputy Director of the Imperial Bureau of Soil Science, Rothamsted Experimental Station

During the last few years, the world has awoken to the dangers threatening it from soil exhaustion caused by short-sighted methods of agriculture. Much has been written on the subject, and at least one country, the United States, has taken active steps to prevent the impending catastrophe. But in many parts of the British Empire and elsewhere the economic incentive to exploit the soil remains too great to be resisted, so that a problem of great urgency awaits solution. Mr. G. V. Jacks, Deputy Director of the Imperial Bureau of Soil Science at the world-famed Rothamsted Experimental Agricultural Station, here describes the whole matter with a lucidity and a freedom from technicalities that will make it clear to every reader.

During the last century, wherever new land has been opened up for settlement, there have been practised kinds of agriculture which have resulted in a depletion of the natural fertility of the soil. Soil-depleting agriculture is almost invariably the rule when land is first settled, and there is nothing particularly blameworthy about this latest world-wide appearance of it. But a remarkable feature of recent settlements has been the rapidity with which symptoms of soil exhaustion have appeared after a country has been opened up. The first symptoms are failing yields, which nobody bothers much about, because they are expected. A later and quite unexpected phase of soil exhaustion has been not a further gradual diminution of yield, but the more or less complete disappearance of the soil itself. It is practically impossible to reduce the crop-producing power of soil to zero however exhaustively it is cultivated, but it has been found that long before complete exhaustion is approached, the soil loses its capacity for remaining in place. A fertile soil, wherever it is formed, has many of the properties of a sponge—it can absorb quantities of water, and possesses considerable internal cohesion. An infertile or exhausted soil loses this water-absorbing capacity and cohesiveness, and breaks down to a mass of separate particles, in which condition it is very readily washed away by water or blown away by wind.

In this way, as a result of the depletion of a mere fraction of the total soil fertility, enormous areas, mainly in North America, Africa, and Australia, have been denuded of soil and are now to all intents and purposes barren wastes. The current wastage of land through this so-called soil erosion is not immediately serious for the world as a whole, since there is still plenty of good land for everybody, but it is becoming serious in certain countries, notably the United States and territories in South and East Africa. It was stated a few years ago that at the then rate of erosion the United States would be incapable of organized existence by the end of the century. For much of Africa, where erosion is a more rapid process, the end of the century would be an optimistically distant date for the end of human dominion over the land.

Summary figures of a national survey made in the United States in 1934 illustrates the extent of the damage done by soil erosion, mainly within the last forty years. Of the total land area 14 per cent had lost three-quarters to all of the soil, 42 per cent had lost one-quarter to three-quarters of the soil, and 30 per cent (much of it unsuitable for agriculture) was uneroded. Apart from the loss of productive soil, incalculable damage has been done by chronic flooding of the main rivers, progressive dessication of the land, and the profound disturbances to the normal regime of ground waters that are produced by the disappearance of the absorbent surface soil and adversely affect agriculture even where no erosion has occurred. The process of erosion, once started, proceeds under its own acceleration in ever-widening circles. It works insidiously striking at the base of social existence while leaving the main superstructure of society untouched. For this reason it never has been, and probably never will be, taken in hand by the community as a whole until it has reached an advanced stage at which the threat to the superstructure becomes apparent.

The cause of soil erosion is often given as the destruction of the natural vegetation which normally affords the soil adequate protection from the erosive action of rain and wind. This is correct up to a point, but there

* Although this article has already been reprinted locally it is being re-published also in the *Journal* both because of its excellence and because it should be as widely read as possible.—*Ed.*

is no reason why the destruction of the natural vegetation, whether forest or grassland, should necessarily be harmful. All agriculture involves such destruction, and it stands to reason that no permanent agriculture is possible where the soil is progressively deteriorating. The real cause of erosion is the practice of an agriculture which does not take full account of the natural limitations of the environment and causes soil exhaustion, which is the invariable precursor of soil erosion, even when stripped of vegetation, and the only certain cure for soil erosion is to utilize the land in a manner which maintains, and preferably increases, its fertility. Such a type of land utilization is general in the highly farmed countries of Western Europe, where, despite prolonged and intensive agriculture, the soils are probably now capable of greater and more sustained production than at any previous time. The agriculture of the Middle Ages was, like the present day agriculture of much of the New World, soil-exhausting, and might ultimately have caused widespread erosion had it not been put on an entirely new basis by the agricultural revolutions of the seventeenth and eighteenth centuries. These resulted in a type of agriculture that, so far as the maintenance of soil fertility was concerned, made the optimal use of the natural qualities of the environment.

In the eroding countries of the New World a comparable harmony between agriculture and the environment does not exist; erosion is, indeed, the most common physical symptom of an absence of such harmony. In these countries the evolution of agriculture has been governed by opportunities—by the potentialities rather than by the limitations of the environment. The latter, however, are now making themselves felt. Nature imposes her own harsh discipline on those—whether man, animal or plant—who cannot or will not play their allotted part in preserving the biotic equilibrium which assures the continuing fertility of the earth. Elimination is the invariable rule in such cases, and soil erosion is a very effective way of eliminating man. Agriculture must either develop into a process that increases the fertility of the soil, or cease altogether. The factors, chief among which is the climate, that determine how the soil must be cultivated so as to increase its fertility are still largely outside human control.

On the other hand, the factor which determines how the land actually is utilized is primarily economic. In general, men will always cultivate the land in the way that gives them the greatest economic advantage, and soil-exhausting agriculture, which implies drawing on the existing fertility reserves, tends to be easier and more immediately profitable than soil-conserving agriculture, which implies investing something in the land to pay a dividend at a later date. Consequently, although the measures required to stop soil erosion and build up soil fertility are simple and understood everywhere, they are not applied on a scale commensurate with the task unless and until the economic conditions of a country make it more profitable to conserve than to exhaust the soil. The first essential step in the soil-conserving agricultural revolution in Britain—the enclosure and pasturing of exhausted arable land—was promoted by the prosperity of the wool trade and the contemporary depression of the grain trade. In recent years one country—the United States—has apparently turned the corner from soil-exhausting to soil-conserving agriculture, not from a recognition of the fatal consequences of continuing soil erosion, but as a result of the disappearance of the export trade for soil-exhausting crops. The Agricultural Adjustment Administration was set up to reduce the acreage of these unsaleable crops; it has survived many vicissitudes to become a powerful agent in encouraging the cultivation, in their place, of soil-conserving crops. American economy is developing along the lines which are making it more profitable to make than to destroy soil fertility. Provided future developments are in the same direction, the problem of soil erosion will solve itself.

These developments are towards a more self-sufficient economy than has prevailed hitherto. As agriculture becomes self-sufficient the limitations of the natural environment assume a much greater importance than they possess in a period of expansion. The countryside begins to take on an appearance dictated by the qualities of the land, and human society a form which harmonizes with the evironment. Permanent agriculture is established and civilization has a chance to develop on a secure foundation. Already we can trace in the United States the emergence of new cultural patterns representing the landscapes of permanent, soil-conserving agriculture. Associated with these patterns there is emerging also a new form of society that is based on the community as the ultimate social unit and rejects the "rugged individualism" which was such a marked feature of the pioneering era. It has been

proved beyond doubt that the individual, working by and for himself and in open competition with his fellows, is incapable of preserving the fertility of the prairie environment; sooner or later, he must destroy the soil in the struggle to maintain his position in society, whereas a co-operating community of farmers acts spontaneously in such a way as to preserve its social base, the land. Unstinted co-operation between occupiers of land is now recognized as so vital to the success of any scheme for soil conservation that the Federal authorities refuse their essential assistance unless co-operation is assured. What co-operation means at the present time— a very embryonic stage in the evolution of permanent agriculture—is that while the owner retains full legal title to his land the community of which he is a member decides how he shall utilize it; and unless the community decides that the land shall be worked so as to conserve its fertility, the very existence of the community itself is threatened.

The necessary requisites for the accomplishment of soil conservation in an eroding region are thus, firstly, an economic system under which it is more profitable to make than to destroy soil-fertility, and second and complementarily, a form of society that can work the economic system. Given these—they are complex functions of the environment—permanent soil-conserving agriculture follows automatically. There is nothing particularly difficult about the technique of permanent agriculture, but the conditions which make its application generally acceptable must obtain. In Britain they have obtained for so long that soil conservation has become the primary concern of agriculture, and not all the outcry for super-efficient farming can shift the deeply rooted instinct of the community to preserve the soil intact. In the United States favourable conditions, first created by the world-wide economic depression, are just beginning to appear. Thanks partly to the neglect of British agriculture and partly to their financial indebtedness to the Mother Country, the main agricultural regions of the British Empire retained their overseas market after the agricultural depression, and have continued to export large quantities of the produce and fertility of the soil. The economic incentive to exploit the soil has been too great to be resisted.

It is doubtful indeed whether agriculture can ever become conservative so long as the farmer is concerned with adapting his practices more to the requirements of a foreign market than to the limitations on land ultization imposed by Nature. In other words, a large measure of self-sufficiency is indispensable to the establishment of permanent agriculture. This is what one would expect on theoretical grounds, and it is fully borne out by recent experience. The United States owes the salvation of its soil to the disastrous breakdown of international trade; other eroding countries may survive to thank the grim economic aftermath of the war for affording the opportunity to reorganize their agriculture on a stable and enduring foundation. It is at least certain that a heavy price is owing for soil exhaustion, but the sooner payment is enforced the less onerous it will be.

A METHOD OF STORING SWEET POTATOES

By R. B. Allnutt, Agric. Officer, Dept. of Agric., Tanganyika

Sweet potatoes can be stored without deterioration for two years or more if they are treated in the following manner. The tubers are dug and then wilted for two or three days. They are next placed in cold water which is brought to the boil and kept boiling for about an hour. After this they are removed, cooled, then either sliced lengthways into three or four pieces or else squeezed out as flat as possible with the fingers, and afterwards dried brick hard in the sun. They are then ready for storing. No special storage vessel is needed. When required for use the dried roots are washed, and then boiled in the ordinary way. The result is said by natives to be even more palatable than boiled fresh roots.

This recipe is used by the natives of Sukumaland in the Lake Province of Tanganyika, an area which has a very dry atmosphere for a considerable part of the year. It is possible that under more humid conditions the results might be less satisfactory, but there must be many large tracts of East Africa where the method would be worth a trial, particularly in districts where it is necessary to insist on the planting of root crops as a precaution against famine but where cassava is unpopular as a food or agronomically unsuitable.

TSETSE-FLIES AND DEVELOPMENT IN KENYA COLONY

PART III

By E. Aneurin Lewis, M.Sc., Ph.D., Entomologist, Veterinary Research Laboratory, Kabete, Kenya

Trapping

The idea of utilizing traps against adult insect pests has received considerable attention since a very early period, and especially during the last two or three decades. Many simple and ingenious types have been devised on the basis of attractiveness to one or more of the senses by which the pests discover food, shelter, mates and suitable breeding sites. The non-return, pyramidal or conical, wire-gauze trap is familiar to most people. The design used for house flies and described by Hughens (1919) was not very much unlike the one used for the tsetse, *G. pallidipes*, by Harris in Zululand, and the box-screen trap introduced by Blunt in Kenya. Balfour (1913) proposed the use of tsetse-fly traps against *G. morsitans* in the Anglo-Egyptian Sudan, and Austen (1922) pointed out that in attempting to devise some practical form of traps, the attraction exerted upon tsetse-flies by moving objects should not be forgotten.

In a published summary of a report on tsetse-fly investigations in Zululand, Harris (1926) stated that *G. pallidipes* came more readily to objects showing horizontal bulk, such as a quadruped or dummies of animals, than those showing vertical bulk such as trees and men. Moving objects attracted the tsetse by sight rather than by scent, and more than stationary ones. Later (1930), Harris produced his now well-known trap, which was instrumental in reducing the density of *G. pallidipes* in Zululand to a very low figure and near to extinction. In a recent communication (September, 1940), Harris informed the writer that his traps in Zululand had brought about a considerable improvement in the tsetse-fly situation, but that the mopping-up of the remaining very small fly-population might take time. It is generally agreed that the total destruction of tsetses is necessary for the prevention of trypanosomiasis in cattle, but in the case of human trypanosomiasis a heavy reduction in the fly density by trapping, without complete extirpation of the fly, might be sufficient for man to be safeguarded from this dread disease (Harris, 1938). Yet complete eradication of all tsetses is, and should be, the aim in all efforts.

The success of the Harris trap with other species of tsetses, and in other territories, has not been so impressive, but it has proved efficient for a limited period against *G. pallidipes* in fly-infested areas of Kenya.

Harris has also pointed out that prior to intensive trapping, a survey with traps should be made. More traps must then be added wherever the fly-density has been shown to be high and persistent. By this means fly-density may rapidly be reduced.

The siting of traps requires special training in, or knowledge of, the factors influencing the visual impression exerted by the trap on the flies.

Swynnerton was already investigating the utility of many designs of tsetse-fly traps in Tanganyika when the Harris trap first gained publicity. In 1933, he published his results with illustrations and specifications of his experimental traps. Referring to the Harris trap, he said that it was excellent for *G. pallidipes*, less good though fair for *G. palpalis*, poor (except at one season) for *G. morsitans*, and useless for *G. swynnertoni*. He found his own Single Screen (SS), and its variant with awnings and buttocks, excellent for both *G. palpalis* and *G. pallidipes*. The other kinds were stated to have given promising results against *G. swynnertoni*, *G. morsitans* and *G. pallidipes*.

Symes (1938) reported that in Kenya the SS awning trap used in his experiments against *G. palpalis* were ineffective as a measure of control.

Jack (1933) in Southern Rhodesia wrote of *G. morsitans* as being attracted to traps when conditions of excessively high evaporation rate prevailed. The need for shade was stronger than the desire for food, and even hungry flies may have failed to be attracted to moving objects. From a distance, visual reaction was towards movement. From short distances, hungry flies were probably attracted by scent. The practical point, according to Jack, was that the Harris trap and traps that acted on the same principle had not proved of any real use against *G. morsitans* in Southern Rhodesia. He suggested, however, that traps may prove to be of value against tsetse-flies in a restricted habitat like that of *G. palpalis*, or such flies as *G. morsitans* and *G. pallidipes* in sufficiently limited areas isolated from invasion by flies from without. To use traps effectively, it would

probably be necessary artificially to isolate the portion of the fly area to be dealt with.

The value of using live animals as bait and in conjunction with traps was tested by Lamborn (1915) in Nyasaland and by Swynnerton (1933) in Tanganyika. The method by the former proved unsuccessful, while that of the latter gave very good results. Other kinds of traps have been tried out by Jack in Southern Rhodesia, Chorley in Uganda, and by scientific investigators in other African colonies.

Experiments with traps by officers of the Department of Veterinary Services in Kenya indicate that a very large number of traps are required to make an impression on the density of *G. pallidipes*. They have to be erected in selected sites, and although new traps catch large numbers where the fly population is dense, they soon deteriorate under tropical climatic conditions. The catches fall more or less rapidly. The cost of the Harris trap, its bulk and weight, do not appear to warrant its preference to the cheaper, lighter, collapsible trap designed by Langridge on a similar principle but which is not always quite as efficient as that of Harris. The traps do not attract *G. pallidipes* when the density is low, and they seem to be less attractive at some seasons than others. It is evident from local experience that the creation of an artificial concentration is necessary to prolong or increase the efficacy of the traps. The application of scent-baits seems to have had some such effect in experiments against *G. pallidipes* in the Lambwe Valley.

Finally, reference may be made to attempts to trap, and to control, tsetse-flies by other methods. Shircore (1920) tried to induce flies to utilize artificial breeding-places. Chorley in Uganda, and Nash in Tanganyika, have also experimented with traps for larviposition. Nash introduced traps in the form of logs which could be rolled to one side when the larvæ had been deposited and the pupæ formed in the ground. The effect of such exposure would be to kill the pupæ. But, as will be mentioned later, the flies do not always use these typical or favoured sites.

Bush Clearing

The wholesale destruction of bush and forest infested with tsetse-flies was at first resorted to in order to preserve human life. It was extended, to some degree, to protect cattle and to reclaim pasture and agricultural land. But, for many years, the ruthless cutting down and digging out of bush, as a means of controlling tsetses, has been considered too drastic and too costly. The discoveries of research workers have indicated also that it is unnecessary in the case of some species, and that there are alternative and more economic methods of control. Nevertheless, where intensive, judicious cultivation and stock farming can be practised without injury to other economic interests, useless wild bush must, as in the past, give way to necessary development. Improved methods of crop production, good management of pasture land and reafforestation, whether under intensive or extensive conditions, may be adopted to secure the value of land after it has been reclaimed or protected from fly infestation.

At the present stage of research into the bionomics of the most common or serious species of tsetses, it has been shown that the removal of bush in narrow strips or cleared barriers is sufficient to prevent further extensions of fly-belts, to protect small, controlled settlements, to provide safe roadways or corridors from a fly-free area through an infested zone to another fly-free area, and to isolate blocks of infested country in order to eradicate the tsetses by measures other than complete destruction of forest.

The width and length of these cleared fly-barriers vary according to the type of country and the ability of the different species to enter or to cross open country and to circumvent the obstruction to their tendencies to spread. They depend also on whether the barrier is to be used for the movement of stock or for motor or other traffic.

As far as *G. palpalis* in Kavirondo was concerned, Symes (1935) recommended clearings of 600 yards along the river and a minimum of 300 yards across. In 1937, further experiments in the Kuja River area showed that *G. palpalis* contrived to cross clearings up to 1,050 yards wide. Larger numbers of flies crossed the cleared strips during the brief periods of floods and the longer wet periods than during the dry seasons. The flies sometimes follow the bank of a river denuded of bush for considerably more than 400 yards, and it has been observed that they will travel many miles if there are small clumps of thickets even at long distances apart. They also follow narrow paths through riverine bush and at times take advantage of tiny streams and ditches.

Summarizing the results of experiments on *G. swynnertoni* by Potts and Moggridge in Tanganyika, Swynnerton said that an 800 yards clearing was quite insufficient to prevent the spontaneous crossing of flies. None was recovered in a 1,400 yards clearing, but trials at

another time of the year and when the fly-density was greater might have produced evidence of crossing. Swynnerton added: "Probably no clearing less than two miles in width will suffice as a permanent barrier against uncarried flies."

Harris (1930) had shown that a 400-yard clearing was not enough to prevent *G. pallidipes* crossing to an island of bush whose line and shadow might be attractive to the fly.

With regard to the width of clearing to safeguard a road, Swynnerton reported: "It was concluded that flies (*G. swynnertoni*) seldom fly out to attack objects for a greater distance than 200 yards over level ground, but that, if the range of vision of flies is increased by a concave contour of the ground, the range of attack will increase, it may be, to 400 yards. A road clearing, that is, should be 600 yards wide at least.

"A road running along the middle of a perfect 1,200-yard clearing was kept fairly infested by movement of people joining on native paths from the fly-bush. This and often pieces of ground re-infested again lost their flies when the human traffic was subjected to being deflied by a picket."

Much successful reclamation has been achieved in Tanganyika by breaking up the fly-infested bush into blocks of different sizes and isolating them by cleared barriers (Tsetse Research Dept. reprint, 1932). The fly in the bush-covered blocks was attacked by various methods: cutting out of thickets to destroy the breeding places of the tsetse; catching by hand with nets or supplying a greater attraction than the catcher himself by using bait cattle or screens and catching the flies off them; poisoning the trees to alter the habitat; the use of traps, preserving the grass unburnt for several years; and sweeping the bush with grass fires at the end of the dry season.

Symes and Vane (1937) reported that the block system together with catching out by means of fly-boys with nets resulted in the reclamation of several square miles of the Kuja River basin from *G. palpalis*. Similar results by trapping and hand-catching with nets and screens have been obtained in the *G. pallidipes* area of the Lambwe Valley.

In Kenya, as in Tanganyika and other territories, there are areas of uninfested land which are rendered inaccessible to cattle by bands of tsetse bush in between. There are other areas which are normally fly-free, but subject to light periodical infestation by flies from adjoining bush or forest.

Barriers or cleared corridors have proved highly valuable in the first of these. Particular examples are those of opening up of the Hurubuhuru Plains and the Kiratu-Oldeani area in Tanganyika. The efficiency of barriers in protecting the other types of areas mentioned in the last paragraph may be illustrated from Kenya or Tanganyika, and in fact from other territories. The utilization of protective barriers against *G. pallidipes* in the Lambwe Valley, Kenya, showed how the contour of the country or the existence of a hill across the line of vision of the tsetse could improve the efficacy of a comparatively narrow barrier. One strip of clearing, 800 yards wide, passing along the foot and along the slopes of a hill proved highly satisfactory in preventing further spread of the flies and in rendering an area of about 30 square miles, hitherto uninhabitable, available for stock. It should be explained that the flies in the bush on the other side of the clearing were being reduced systematically. Another clearing several miles lower down the infested valley, where there was no hill, was not effective at 800 yards width. It was increased to 1,000 yards and had to be supported by a belt of discriminative clearing before the flies were prevented from crossing. The clean-boled trees at the lower edge of the clearing were left standing. The flies retreated into the dense, thicketed bush, and the upper block was protected from continuous reinfestation from the lower block.

Still another "barrier" was tried half way down the valley. In this case, however, only thickets were destroyed and the large and medium-sized trees were not cut down. The grass grew rapidly and spread over the bare patches where the thickets had been burnt. Frequent screen-patrols failed to capture more than a few flies within this thinned-out strip, although *G. pallidipes* was fairly numerous on the thicketed margins. Unfortunately, a very extensive grass-fire swept through the valley soon after the overseer left for military service. It drove flies across this wooded barrier, and thus increased the fly-density in a block which it was hoped to clean of thickets and to trap intensively in conjunction with screen-catching.

Discriminative Clearing

Discriminative clearing of bush is the destruction of only that amount or type of bush which supplies the conditions necessary for the multiplication or survival of the tsetse-flies concerned. To destroy the "favoured" breeding-places is not enough, for some species of fly deposit their larvæ in different habitats and

according to weather or other conditions. This is definitely the case with *G. pallidipes* in many parts of Kenya. Jackson (1937) has shown it to apply to *G. morsitans* in Tanganyika, and it has been noted with *G. swynnertoni* in the Narok (Osero) area of the Masai Reserve.

According to an experiment by Swynnerton (1921), *G. brevipalpis* disappeared at once by removing the undergrowth or "furniture", but *G. pallidipes* entered in small numbers. It seemed that a further reduction of the light thickets might have prevented *G. pallidipes* also.

Nash (1936) has carried out some interesting field experiments on the influence of discriminative or partial clearing on *G. tachinoides* and *G. submorsitans* in Nigeria. In his account of the preliminary work, he stated, "The most important conclusion derived from the experiment is that the tsetses live very close to the critical temperature zone in the late dry season . . .", which supported his previous suggestion that if only the peripheral intrusive thickets, which serve as windbreaks, be removed, it is quite possible that the insulation of the riverine forest and forest island would be destroyed. Consequently, if this is confirmed, the partial clearing referred to will drive out or destroy the tsetses.

The difficulty that has not yet been surmounted is the degree of partial clearing which is inimical to the different species, when the infestation is due to one species, and when two or more species are involved. In Kenya there are mixed belts of *G. palpalis, G. pallidipes, G. brevipalpis,* and *G. fuscipleuris; G. brevipalpis, G. pallidipes,* and *G. austeni; G. pallidipes, G. brevipalpis* with *G. longipennis* in the areas adjoining; *G. swynnertoni, G. pallidipes,* and *G. fuscipleuris;* and *G. pallidipes* with *G. longipennis.* The belts are seldom of one species as is the case over large areas in other territories.

Densification of Bush

In Tanganyika, isolated blocks of fly country have been protected from fires by the formation of barriers and firebreaks. Fires were excluded in order to allow the natural vegetation to grow and to become more dense. This method of "densification" has been applied to lightly thicketed or savanna country where *G. swynnertoni* prevails. The results of experiments at Shinyanga so far show that densification has been followed by a speedy reduction in the numbers of this fly. Nash (1939) said that a large-scale policy of densification of woodland by fire-exclusion would be beneficial to *G. palpalis, G. tachinoides* and *G. morsitans* in the northern parts of Nigeria, enabling all three common species to extend their range, owing to the greater protection against adverse climate conditions afforded by thicket vegetation. He was of the opinion that it would be inadvisable to practise fire exclusion in *G. morsitans* belts. Densification, he thought, could only succeed as an anti-tsetse measure in the southern parts of Nigeria, where a cooler, moist climate makes tsetses prefer more open conditions, whilst a high rainfall tends to produce excessively dense vegetation.

The writer's experience in Kenya tends to the view that while most of the species whose habits are known are intimately associated with thicket and fairly heavy forest, they seem not to seek really dense, dark and damp sites in the heart of the vegetation. They will utilize such sites for breeding and shelter if conditions are extremely hot and dry or if they connect more or less directly with paths and tracks which they can use for ranging throughout the bush. *G. brevipalpis, G. fuscipleuris* and *G. austeni* may occasionally frequent the deeper recesses, but even these shade-loving species seem to prefer dry places or the margins of thickets and forest. Symes and Nash have noted the absence of *G. palpalis* in thick bush, and it is well known that *G. pallidipes* usually selects light thickets or the periphery of thicket clumps.

Densification appears to be hedged with difficulties, except perhaps in the case of some areas infested with *G. swynnertoni,* but like the discriminative removal of bush, it may serve to drive out the tsetses so that subsequent direct measures of development may be introduced to consolidate the reclamation.

Game Control

The relation between tsetse-flies and the game of Africa was observed as long ago as 1857, when Livingstone and, later, other travellers wrote of their journeys in different parts of the continent. Since those early years, research workers have studied the subject more closely, and have discussed the influence of the natural fauna on the different species of tsetse-fly.

On the one hand, the desire to preserve game, and on the other the wish to eradicate the tsetse, even at the cost of reducing or controlling the game, have aroused a good deal of controversy.

Harris favoured the control of game because he believed that they were the principal carriers

of *G. pallidipes* from one area to another. When at a low density, the flies, according to Harris, no longer move unaided over extensive areas, but solely in the company of the large game animals. The tsetses feed entirely on vertebrates, and he claimed that a trapping campaign must therefore be to concentrate the food of the tsetse into the smallest possible area. When this has been done, the area in which the animals have been concentrated may be trapped intensively, using a large number of traps. He reported that the game could be controlled successfully by erecting several miles of hessian screen at a stated height from the ground.

Jack (1934) put forward his views supported by long experience of game control as a measure against the tsetse in Southern Rhodesia. He explained, however, that he was dealing exclusively with *G. morsitans,* which is specially associated with game, and that it had not been suggested by him that removal of game would eliminate species other than *G. morsitans.* Having set himself the question: "Is it feasible by game reduction to check the spread of tsetse and to eliminate it from infested country", he said, "Obviously the question can only be decided by experiment, and Southern Rhodesia is the only country which, to date, has been forced to experiment with the measure on a really extensive scale."

It is not necessary here to enter into the detailed arguments for and against game control as a means of eradicating tsetses. Jack has reported that the arrest of the fly's (*G. morsitans*) spread can be accomplished, and that, if necessary, areas can be cleared of fly by game reduction. Chorley (1938) stated, in the Annual Report of the Division of Entomology for 1937, that the destruction of game as a defensive measure against the encroachment of the tsetse-fly, *G. morsitans,* in Southern Rhodesia was first adopted as an experiment in the Wankie district in 1919. The results of this experiment were entirely satisfactory, and the same measures were applied to other districts. A policy of controlled and intensive game destruction within a cordon or buffer zone protected by two long fences, at first ten miles apart and later extended to twenty miles, proved successful in stopping the advance of fly from the infested areas on to European settlements. Not only had this immediate object been gained but it has been found possible in practice to recover ground. He added, "The experimental stage has passed. To-day it is a proved measure which can, with confidence, be applied in any area on the periphery of a fly-belt wherever land is required for European or native development." "The cost, both financial and ethical, has been great and is an ever mounting total, and the question of how far we shall bite into the fly-belt, reclaiming land for which at the moment there is no immediate want, is one which will soon demand an answer."

It was reported that a total of approximately 4,000 square miles had been reclaimed up to the end of 1937. De-flying stations or clearing chambers were erected and used to prevent the spread of fly by pedestrians, cyclists, cars and lorries into the protected cordon.

It may be noted at this juncture that a similar cordon protected from game and utilized for settlements in Nyasaland proved successful when the buffer zone was seven miles wide. A strip of one mile was definitely ineffective.

Swynnerton (1936) expressed his reluctance to slaughter game as a measure of controlling tsetse-flies before accurate data were available to prove the necessity of such an attack, and that even if proof were obtained, he hoped that a practical alternative would be sought.

The deductions from observations made by members of the Tanganyika Tsetse Research team throw some doubt on the advisability and practicability of game control and destruction, especially against species which are not peculiarly adapted to game as *G. morsitans* appears to be. Each of the species presents a separate problem in connexion with food control.

Discussion

A much larger amount and more detailed information than has been possible to include in this general account has been accumulated and published on the tsetses in the different African territories. In each territory attention has been concentrated on the species that predominate over wide areas, or a species that has presented local problems of outstanding importance. In most countries substantial sums of money have been expended on studies of the flies and on measures for their control.

G. morsitans is widely distributed and of major importance in many parts of Africa. It has therefore been the subject of considerable research for many years. In Southern Rhodesia it has successfully been attacked chiefly by the means of game control, and in Tanganyika and Nyasaland, for instance, other measures or modifications have been suggested or practised. This species of tsetse has not been recorded in

Kenya, but if its suspected occurrence in the north-western districts is confirmed the situation may become serious in view of the increased activities associated with present-day conditions, and the experience in other countries may be of great value to the Colony.

G. swynnertoni also has received much attention in Tanganyika. It is a species that has definitely gained ground in what has been described as one of the best grazing districts in Kenya, an area which is also popular with game-hunting expeditions. Measures for its control indicated by Swynnerton (1936) include the formation of barrier clearings, possibly the exclusion of fires, and discriminative clearing of bush.

The species that are of greater importance to Kenya Colony are *G. palpalis, G. pallidipes, G. brevipalpis, G. fuscipleuris, G. austeni,* and *G. longipennis.* Several of these usually occur together in the same fly-belt, and are seldom found as a one-species infestation, as may often be the case with *G. morsitans* and *G. swynnertoni. G. longipennis,* however, seems to be able to live in areas where the other species cannot survive.

G. palpalis has attracted the attention of numerous workers in practically every country where it occurs—from the West Coast to East Africa; and the situation with regard to this species has been thoroughly studied in Kenya. Symes has shown that its control is not so easily achieved as it was thought to be in earlier years. Nevertheless, he proved that the task was not impossible, and that by isolating infested "blocks" of bush with protective barriers and catching-out the fly population many miles of land in infested valleys could be reclaimed.

Reference has already been made to the enormous reduction of *G. pallidipes* by trapping in South Africa, and to the success of partial clearing and the use of traps against this fly in the Lambwe Valley, South Kavirondo, Kenya Colony. Discriminative clearing has produced satisfactory results in Tanganyika.

Less work has been done on *G. brevipalpis* and *G. austeni,* and extremely little attention has been paid to *G. fuscipleuris* and *G. longipennis.*

It is evident that methods of controlling at least some species of tsetse-fly exist. As yet there is no universally applicable method of control or eradication. Barrier clearings, discriminative clearings, densification of bush by exclusion of fire, late burning, destruction of game, the breaking-up of bush into small blocks, trapping and hand-catching are all employed in the control of fly as circumstances, environment and species of fly demand. Failure to discover some cardinal principle upon which eradication measures can be based tends to make Governments, administrative officers and even scientists fight shy of tsetse-clearing projects, and at times to fall back on such consolations as that the land is being saved for posterity. This would imply that were the land reclaimed to-day it would inevitably be destroyed—a grave reflection on our trusteeship. However, one need by no means despair because no royal road to success has yet been opened; existing methods of attack, applied under the direction of experts, who choose and adapt them to the immediate situation, have already given excellent results when followed up sufficiently closely by systematic, carefully planned settlement. There is reason to believe that the practice of good farming and proper management will materially assist in driving back and in eradicating the tsetses.

Tsetse-fly control is an essential item of development. It is one among several other factors which have already been mentioned in the earlier part of this article, and it can be achieved most expeditiously and economically by full collaboration not only between departmental officers in the Colony but also between these officers and workers on related subjects outside, and the public.

A need of paramount importance is that of a plan of approach to the fly problem, a comprehensive plan that would be beneficial to the development of agriculture in its widest sense, and to the welfare of the people—European, Asian and African. It would contribute to a clearer understanding of what is required of technical and other officers who are periodically called upon to investigate tsetse-infested areas and problems affected by the occurrence of fly. It would stimulate the requisite interest in these important pests, and encourage farmers of all classes to undertake those measures which are now available. Such a plan should be sufficiently flexible to allow for modifications and new methods as research workers discover other means of attack. It should permit operations on a moderate scale to begin almost immediately but not to outstrip re-settlement or proceed too far in advance of the requirements of economic development.

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PINEAPPLE EXPERIMENTS IN ZANZIBAR

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In 1937 it was recognized that pineapples grown in the Protectorate were of a very high standard and the possibility of canning fruit for the best-quality markets was then mooted. Of the two varieties of pines commonly grown by smallholders, Smooth Cayenne and Ripley Queen, the former was more abundant and more suitable for canning. Cultivation was most primitive and was limited chiefly to a few scattered plants around peasants' dwellings.

In 1938 several acres of pineapples were planted at the Kizimbani Experiment Station to provide planting material for possible future development and to investigate cultural and manurial problems. The soils at Kizimbani consist of rather poor light red loams, somewhat acid, and deficient in organic matter. The experiments described below were carried out on land which had borne clove trees for at least sixty years prior to 1934, when the trees were felled and the area was planted with various annual food crops for a period of four years.

Weather.—The annual rainfalls at Kizimbani during 1938, 1939 and 1940 were 86.57, 71.57 and 84.03 inches, of which approximately 50 per cent fell during the periods March to June and 30 per cent from October to December. The extreme mean monthly minimum and mean monthly maximum temperatures recorded during the period March, 1938, to March, 1941, were 66.0° F. and 90.9° F. respectively, the lowest minimum and highest maximum daily temperatures being 61.0° F. and 94.0° F. respectively. The hot season occurs during the months of January, February and March, when hot dry winds from the north-east tend to cause drought.

Pineapple Varieties.—The Smooth Cayenne variety grown under luxuriant conditions in Zanzibar will produce fruit as heavy as twenty pounds or more, but when grown under commercial conditions the weight is restricted by close espacement to between three and seven pounds. For best-quality canning, a pine should be cylindrical rather than oval and should weigh more than four pounds. The planting material used in these experiments consisted entirely of suckers, as other types of planting material, i.e. ground shoots, slips and crown slips, are extremely rare in Zanzibar.

Literature.—Published literature on pineapple manurial and spacing experiments is sparse and conflicting. Olds and Dennett [1] (1933) in Malaya report that phosphatic manures produced a definite response in vigour, early maturity and yield. Coombes [2] (1938) in Mauritius shows that large dressings of sulphate of ammonia (approximately 6 cwt. per acre) were better than smaller dressings, giving fruits of higher quality with a greater mean weight. Davis [3] (1938) in Queensland indicates that plants on plots receiving a complete manure usually develop better and, in the first year, produce more fruits of superior size, shape, colour and chemical composition than plots receiving no manure, or sulphate of ammonia and superphosphate only. He therefore stresses the importance of potash. Olds [4] (1937) again stresses the importance of phosphates in Malaya, but his applications of artificial manures appear to be very small for a bulky tropical crop.

The experiments in Zanzibar which are described below were therefore laid down in the absence of definite general information with regard to either manurial or spacing treatments.

Manurial Experiment

Layout.—Six randomized blocks of eight plots.

Plot Size and Plant Espacement.—Plots 30 × 27 feet containing three bands four feet apart; each band consisting of three low ridges two feet six inches apart. The plants were two feet six inches apart in the row. This espacement is equivalent to 108 plants per plot or 5,808 plants per acre. The experiment was planted on 20th April, 1938.

Treatments

1. N.	5. N.K.
2. P.	6. P.K.
3. K.	7. N.P.K.
4. N.P.	8. Control (no manures).

N.—Sulphate of ammonia, 250 lb.
P.—Superphosphate, 250 lb.
K.—Sulphate of potash, 200 lb.
} Per acre per annum.

The applications were made in equal half-yearly dressings soon after the main and short rains, the manures being scattered around the bases of the plants. Cultivation, weed eradication, sucker removal and replanting were carried out as necessary.

Harvesting.—Harvesting began in November, 1939, and continued at frequent intervals—every four to six days during the main crop season (October to March) and fortnightly for the rest of the year. Records of the number and total weights of fruits harvested from each

plot, and the number of fruits produced in each plant position, were made in the field at the time of harvesting. The pines were weighed with their tops and with three inches of stem remaining attached to the fruit. The results were grouped and analysed as follows. For comparisons the figures have been converted into units per acre, and the relative order of performance is inserted in brackets.

First Canning Season, November, 1939, to March, 1940

Table I

Treatments	Fruits per acre	Weight of fruit per acre	Average weight of of pines
		Tons	*Lb.*
N.	4,490 (1)	10·699 (1)	5·34 (2)
P.	3,236 (5)	6·270 (6)	4·34 (8)
K.	3,146 (7)	6·154 (7)	4·38 (7)
N.P.	3,693 (2)	9·170 (2)	5·56 (1)
N.K.	3,424 (3)	8·138 (3)	5·32 (3)
P.K.	2,483 (8)	4·889 (8)	4·41 (6)
N.P.K.	3,307 (4)	7·778 (4)	5·27 (4)
O. Control ..	3,236 (5)	7·198 (5)	4·98 (5)
Difference required for 5 per cent significance ..	995·6 fruits	2·511 tons	0·626 lb.

It is clear therefore that sulphate of ammonia has produced a larger number of fruits per acre, a greater weight per acre, and fruits of greater average size. On the other hand, sulphate of potash appears to have had a depressing effect, especially noticeable when used in combination with superphosphate, and even with sulphate of ammonia. Superphosphate does not appear to have a marked depressing effect, although when used in the absence of nitrogen the average weight of the fruit is significantly smaller than in the control.

Second Canning Season, October, 1940, to March, 1941

Table II

Treatments	Fruits per acre	Weight of fruit per acre	Average weight of of pines
		Tons	*Lb.*
N.	2,537 (4)	6·014 (3)	5·31 (1)
P.	2,268 (6)	4·165 (6)	4·11 (6)
K.	1,891 (8)	3·313 (8)	3·92 (7)
N.P.	2,635 (2)	5·981 (4)	5·09 (3)
N.K.	2,608 (3)	6·094 (2)	5·23 (2)
P.K.	2,178 (7)	3·637 (7)	3·78 (8)
N.P.K.	2,752 (1)	6·230 (1)	5·07 (4)
O. Control ..	2,438 (5)	4·709 (5)	4·33 (5)
Difference required for 5 per cent significance ..	(Insignificant)	1·252 tons	0·46 lb.

Discussion of Second Canning Season's Effects

At first sight, the treatment effects were not so pronounced as during the first canning season as there was a levelling up as well as a general decrease in yields during the second canning season. The effects, however, can largely be explained by the fruiting behaviour of the pineapple plant which, when grown from a sucker, does not normally produce fruit within eighteen months from the time of planting, and frequently does not flower until a year later than that. The effect of nitrogen was to bring 77 per cent of the plants into the early fruiting category (i.e. they fruited within eighteen months of planting) and 23 per cent continued to grow to flower at a later date. Thus 77 per cent became ratoons and only the most vigorous of them would produce a second fruit in time for the second canning season. On the other hand, only 43 per cent of the plants in the P.K. plots fruited during the first canning season, and over 57 per cent continued to grow to flower at a later date. Thus, in the second canning season, the P.K. plots contained about two and a half times as many plants which had not yet fruited as the N. plots. The fact that no significant difference existed between the numbers of fruits produced by the different manurial treatments in the second canning season indicates that the nitrogen-treated plots rapidly recovered from this handicap and equalled the performance of the non-nitrogen treatments.

However, the nitrogenous treatments again produced significantly larger fruits and this resulted in the total weight of fruit harvested being significantly greater than from the non-nitrogenous treatments. Sulphate of potash, alone and with superphosphate, produced effects which were even inferior to the no-manure plots.

First and Second Canning Seasons Combined

Table III

Treatments	Fruits per acre	Weight of fruit per acre	Average weight of of pines
		Tons	*Lb.*
N.	7,027 (1)	16·713 (1)	5·33 (2)
P.	5,503 (6)	10·435 (6)	4·25 (6)
K.	5,037 (7)	9·466 (7)	4·21 (7)
N.P.	6,328 (2)	15·152 (2)	5·36 (1)
N.K.	6,032 (4)	14·231 (3)	5·28 (3)
P.K.	4,661 (8)	8·562 (8)	4·11 (8)
N.P.K.	6,059 (3)	14·008 (4)	5·18 (4)
O. Control ..	5,674 (5)	11·907 (5)	4·70 (5)
Difference required for 5 per cent significance ..	1,165 fruits	2·765 tons	0·383 lb.

The combined analysis again shows that the effects of nitrogen are most marked.

Differences in Fruiting Between the Two Seasons' Records

The interaction between seasons and treatments is not statistically significant. On comparing the figures given in Tables I and II, however, it is apparent that there was a general reduction in the number of pines, the total weight of fruit and the average weight of pines during the second canning season. These effects are probably due to several factors, including differences in weather, differences in the proportion of plants to ratoons, delay in fruiting for such plants as had to be replaced by new suckers, and possibly to a reduction in soil fertility.

Out-of-Season Fruit

During the months April, 1940, to September, 1940, inclusive a total of 120 pines weighing 567.4 lb. was harvested from this experiment. Although this fruit would probably not be used for canning, statistical analysis of the yield figures throws additional light on the effect of the manure, and in Table IV the yield of out of season fruit has been calculated as yield per acre. Statistical comparison of the average weight of pines in the different treatments was impossible as the data were insufficient.

Table IV

Treatments	Fruits per acre	Weight of fruit per acre	Average weight of pines
		Tons	*Lb.*
N.	143 (4)	0·283 (4)	4·43 (4)
P.	18 (8)	0·030 (8)	3·75 (8)
K.	54 (7)	0·104 (7)	4·35 (5)
N.P.	188 (2)	0·437 (2)	5·20 (1)
N.K.	278 (1)	0·635 (1)	5·12 (2)
P.K.	90 (6)	0·152 (6)	3·79 (7)
N.P.K.	188 (2)	0·416 (3)	4·95 (3)
O. Control ..	117 (5)	0·212 (5)	4·08 (6)
Difference required for 5 per cent significance ..	127 fruits	0·256 tons	—

The effects of nitrogen on the fruiting behaviour both during and between the canning seasons are therefore similar.

Sulphate of Ammonia and Early Maturity

Table I indicates that the general effect of nitrogen is to promote vigorous growth entailing a high percentage of fruiting in the first canning season, as detailed in Table V.

Table V

Treatments	Percentage of plants fruiting in first canning season
N.	77·3 (1)
P.	55·7 (5)
K.	54·2 (7)
N.P.	63·5 (2)
N.K.	58·9 (3)
P.K.	42·7 (8)
N.P.K.	56·9 (4)
O. Control ..	55·7 (5)

The fruit picked during the first month of each canning season consisted of a large proportion of pines from plots receiving nitrogen. Furthermore, considering each treatment separately, the ratio of the number of pines picked in the first month of each canning season to the total number picked for that season, was higher in the case of plots receiving nitrogenous dressings than in those receiving no nitrogen.

Fruiting Capacity

A summary of the fruiting behaviour is given in Table VII.

Table VII

Fruiting Record (To 1st June, 1941)

Treatments	Number of planting positions		
	No fruit	One fruit	Two fruits
N.	36	396	216
P.	97	467	84
K.	97	489	62
N.P.	63	417	168
N.K.	57	442	149
P.K.	140	465	43
N.P.K.	67	437	144
O. Control ..	75	456	114
Total ..	635	3,569	980

The remarkable capacity of sulphate of ammonia to promote fruiting contrasts strongly with the effects of P.K., which appears to have had a delaying action.

Spacing Experiment

Layout.—Eight randomized blocks of three plots each.

Plot Size and Manurial Treatment.—Plots of 60 × 27 feet. Artificial manures were applied around the plants over the whole experiment at the rate of 250 lb. sulphate of ammonia, 250 lb. superphosphate and 200 lb. sulphate of potash per acre per annum in equal half-yearly dressings. The experiment was planted on 22nd April, 1938.

Treatments.—Three different espacements on the flat:—

Wide.—Bands of plants consisting of three rows 2′ 6″ apart with plants 2′ 6″ apart in the row. A space of 4′ was left between each band. This is equivalent to 5,808 plants per acre

Medium.—Bands consisting of four rows 2′ apart with plants 2′ apart in the row. A space of 3′ was left between bands. 9,680 plants per acre.

Close.—Bands consisting of four rows 1′ 6″ apart with plants 1′ 6″ apart in the row. A space of 4′ 6″ was left between bands. 12,906 plants per acre.

The amount of space allocated to each plant is not inversely proportional to the number of plants per acre as the spaces between bands in the different espacements are not proportional. Cultivation, weed eradication, sucker removal, replanting and harvesting were carried out as necessary.

First Canning Season, November, 1939, to March, 1940

Table VIII

Espacement	Fruits per acre	Weight of fruit per acre	Average weight of pines
		Tons	*Lb.*
Wide	3,180 (3)	7·757 (3)	5·47 (1)
Medium	4,332 (2)	9·292 (2)	4·80 (2)
Close	7,848 (1)	14·946 (1)	4·27 (3)
Difference required for 5 per cent significance ..	918 fruits	2·016 tons	0·246 lb.

Therefore, on number of fruits, close spacing ⩾ medium ⩾ wide spacing; on weight of fruits per acre, close spacing ⩾ medium and wide spacing; on average weight of fruit, wide spacing ⩾ medium ⩾ close spacing.

Second Canning Season, October, 1940, to March, 1941

Table IX

Espacement	Fruits per acre	Weight of fruit per acre	Average weight of pines
		Tons	*Lb.*
Wide	2,252 (3)	4·398 (3)	4·37 (1)
Medium	3,647 (2)	6·268 (1)	3·85 (2)
Close	3,680 (1)	5·745 (2)	3·50 (3)
Difference required for 5 per cent significance ..	467 fruits	1·125 tons	0·355 lb.

Thus, on number of fruits, close and medium spacings ⩾ wide spacing; on weight of fruit per acre, medium and close spacings ⩾ wide spacing; on average weight of pines, wide spacing ⩾ medium and close spacings.

Medium spacing is almost significantly better than close spacing, the actual difference in the average weight being 3.53 lb., whereas a difference of 3.55 lb. is required for five per cent significance.

First and Second Canning Seasons Combined

Table X

Espacement	Fruits per acre	Weight of fruit per acre	Average weight of of pines
		Tons	*Lb.*
Wide	5,432 (3)	12·155 (3)	5·01 (1)
Medium	7,979 (2)	15·560 (2)	4·37 (2)
Close	11,529 (1)	20·692 (1)	4·02 (3)
Difference required for 5 per cent significance ..	982 fruits	2·243 tons	0·206 lb.

On number of fruits and on the weight of fruits per acre, close spacing ⩾ medium ⩾ wide spacing; on average weight of fruits, wide spacing ⩾ medium ⩾ close spacing.

Interaction Between Treatments and Seasons

Table XI

Espacements	Difference between first and second canning season	
	Fruits per acre	Weight of fruits per acre
		Tons
Wide	928	3·359
Medium	685	3·024
Close	4,168	9·201
Difference required for 5 per cent significance ..	982 fruits	2·243 tons

Thus, reviewing the results of the spacing experiments over two seasons, there has been a drop in the performance of each spacing, possibly accounted for by a reduction in soil fertility. The decrease in the average size of fruit as time progressed is very pronounced, especially in the close espacement.

Out-of-Season Fruit

During the months April, 1940, to September, 1940, inclusive, only 357 pines weighing 1,560 lb. were reaped from this experiment. Although wide and medium espacements gave superior yields, the important point from a

canning point of view is that no type of spacing caused a large proportion of plants to produce fruit in the first out-of-crop season.

Fruiting Capacity at Different Espacements

The percentage of positions which gave one fruit varied in the three treatments only between 73.4 and 74.7, thus, compared with the action of different manurial treatments recorded above, spacings had little effect on the fruiting capacity.

Future Experimental Programme

The above experiments are being continued with certain modifications. The individual weight of every pine reaped is now being recorded, and the manurial dressing in both experiments have been increased. Two additional experiments have also been laid down, viz.:—

(1) A uniformity trial.

(2) A factorial experiment of 81 plots in which the following treatments are combined:—

(*a*) Application of sulphate of ammonia at three different levels.

(*b*) Application of a mixture of superphosphate and sulphate of potash at three different levels.

(*c*) Planting at three different spacings.

Summary

The results of a manurial experiment and a spacing experiment on pineapples are described up to the end of the second canning season.

Applications of sulphate of ammonia caused increases in—

(1) the number of pines reaped per acree;

(2) the total weight of fruit reaped;

(3) the average weight of fruit, and

(4) the number of pines which matured in the first month of both the first and second canning seasons.

Sulphate of potash and possibly superphosphate appear to have had a depressing effect on yield and on the fruiting processes in general. Close spacing in the field caused large increases in the weight and number of fruit harvested per acre, but decreased the average weight of the individual pines.

Acknowledgments

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A USE FOR SAPONINS AND SOME POSSIBLE LOCAL SOURCES

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To extinguish a fire the normal method is to pour water on to the flames, but in great conflagrations of oil or spirits this is quite useless as they float on the surface of the water and continue to burn. With the increasing use of oil products throughout the world it has become necessary to evolve special methods of fire extinction. It is possible to extinguish burning petrol in a tank by applying small quantities of water in a finely atomised condition on the burning surface; the water forms a thin screen for the exclusion of air, an effect accentuated by the formation of steam. Another method of extinguishing burning petrol, and more especially fuel oil, is by bombarding the burning surface with water under pressure in a finely divided state, the particles of water in contact with the burning material forming a temporary but incombustible emulsion.

The practice most generally adopted for protecting oil and petrol in storage tanks, etc., is to apply a foaming substance, containing carbonic acid gas, to the surface of the oil.

Foam of a suitable nature is obtained by mixing saturated solutions of bicarbonate of soda and aluminium sulphate with a stablizer. The stabilizers used have been saponin, glue, liquorice powder or quassia bark.

Saponins are water-soluble glucosidal substances, which are found in more than 60 families and over 400 species of flowering plants. Saponin, when dissolved in water and agitated, produces foam and commercial saponin is made by boiling the powdered plant material in water, evaporating the extract to dryness and extracting the residue with alcohol, from which solution a powder is deposited on cooling.

Commercial saponin has been obtained from the Soapwort, *Saponaria officinalis* L., Soapberry, *Sapindus Saponaria* L., Panama Bark, *Quillaja saponaria* Mol., Milkwort, *Polygala Senega* L., and Liquorice, *Glycyrrhiza* spp. mainly *G. glabra* L. Of these, unfortunately, only the Soapberry, *Sapindus Saponaria,* is found in East Africa. This is a small tree about 20ft. tall which, in the past, has been planted by missions and as an avenue tree in the towns of Tanga, Dar es Salaam and Zanzibar. Its fruits used to be much sought after by the natives as a substitute for soap for washing clothes. This tree does not appear to be in a sufficient quantity to be used as a local commercial source of saponin.

When the possibilities of the local manufacture of fire extinguishers was examined, it was through Mr. A. T. and Mrs. G. M. Culwick that a local saponin-containing plant was found. Discussing native medicinal plants in their book *Ubena of the Rivers,* they recorded the use of the root of a shrub, *Randia vestita* S. Moore, in the treatment of gonorrhœa. The root is shredded and steeped in water for about half an hour; the liquid is then whisked to produce a froth, which is skimmed off and drunk night and morning.

Laboratory examination showed that it contained a saponin and it was tried on patients in the Sewa Haji Hospital, Dar es Salaam. It was found to have a strong diuretic action but no specific effect. The saponin is apparently in sufficient quantity to make a good foaming mixture for fire extinguishers and the roots of the shrub are in demand for this purpose, but they have the disadvantage of being tough, woody and difficult to grind into a fine powder.

The following indigenous plant materials used by East African natives as soap substitutes might repay investigation as possibly yielding foaming materials:—

(1) Fruits, bark, wood chips and roots of the Desert Date, *Balanites aegyptiaca* Del. The bark and fruits are also used as a fish poison and the fruits are toxic to freshwater snails, which are carriers of *Bilharzia,* and to the carriers of Guinea-worm. It is a spiny evergreen tree to 30ft. tall, widespread in low rainfall areas throughout East Africa. There are some twenty other species of *Balanites,* six of them recorded in Tanganyika and Kenya, and all in low rainfall areas except *B. Wilsoniana* Dawe & Sprague, a deciduous forest tree to 120 ft. tall found in Tanganyika, Kenya and Uganda.

(2) Raw unripe fruits, the fresh roots and bark of *Barringtonia racemosa* Bl. are used as a fish poison but when dried apparently are not toxic. This much-branched deciduous tree, 40 ft. tall, with long pendulous racemes of cream flowers, is locally common on the banks of streams and on the margins of swamps down the East African coast.

(3) The bark of the giant climber, Sea Bean, or St. Thomas's Bean, *Entada phaseoloides* Merr. It has woody jointed pods 5 ft. long, containing large, round, glossy brown, flattish seeds about 2 in. in diam. and nearly ¼ in. thick, in which saponin has been recorded. It has a scattered distribution throughout East Africa and is common in bush and forest in the coastal districts.

(4) The fruits, seeds and leaves of *Phytolacca dodecandra* L'Herit, a liane in forest but a scandent shrub in dry areas. It has glossy green leaves and long racemes of inconspicuous small yellow-green flowers and small orange or red berries. It is a relative of the Pokeweed and the fruits and roots are known to contain saponin, that in the fruit being toxic. Its usual habitat is forest margins, but it is also found in dry areas, probably as a forest relic. It is recorded throughout East Africa except Northern Rhodesia.

(5) The fruits of two other Randias closely related to *R. vestita, R. nilotica* Stapf in Uganda, Kenya and Tanganyika, and *R. Taylori* S. Moore in Tanganyika. *R. nilotica* was at one time thought to be the same as the Indian *R. dumetorum* Lam. which also has fruits that serve as

soap and is used as a fish poison. *R. dumetorum* contains 38 per cent saponin.

(6) The bark, especially the root-bark, and the pounded seeds of the Tree Violet, *Securidaca longipedunculata* Fresen., are used as soap substitutes. The root-bark contains 4 per cent saponins and one investigator isolated *Securidaca* saponin from the stem bark. It has small, attractive, sweetly scented flowers of various shades of violet and oblong yellow-green to red winged fruits 2 in. long. It is found throughout East Africa, except Zanzibar, more commonly in the south.

(7) The sawdust of a rare tree, *Ternstroemia polypetala* Melch., first described in 1934 from rain forest in the Ulugurus and since found at Dabaga in the Iringa Highlands, Tanganyika, is also used as soap.

The foregoing being all trees or shrubs, the same difficulty will be encountered in powdering those species in which the wood, bark or roots are used as in the case of *Randia vestita*.

There are also a number of herbs which are used as soap substitutes by the natives. The most important belong to the genus *Dolichos* in the Pea Family. These species have tuberous roots, which are the part used, some up to 30 lb. or more in weight. Their stems, either erect or climbing, are produced annually and they frequently flower before their leaves are fully developed. Their leaves are trifoliolate, alternate, leaflets usually ovate, glabrous but usually pubescent; flowers pea-like, pink or red to mauve in few to many-flowered racemes or panicles. They are common in *Brachystegia* woodland or *Acacia-Combretum-Commiphora* bush in fairly low-rainfall areas. The species are:—

Dolichos brachypus Harms; root toxic; a fish poison. Originally recorded from the Transvaal, but found in Mozambique, Rhodesia and in Tanganyika at Bukoba, the foot of the Pares and Kilimanjaro.

D. Buchananii Harms, the Bully Beef Plant, so called because the fleshy root, when cut in half, looks like bully beef; used as a fish poison; common southwards from the Central Line, Tanganyika into Nyasaland and Northern Rhodesia.

D. kilimandscharicus Taub., as its name implies, is common around Kilimanjaro, also Meru, and is found in Kenya.

D. lupiniflorus N. E. Br., another Bully Beef Plant, which has been suspected of poisoning stock, it is locally common around Meru, Tanganyika. Found also in Uganda and around Nairobi.

D. Maitlandii Bak. f., originally recorded from Uganda, but common in northern Tanganyika and in Kenya, is of importance to the Masai, as the lather obtained from the roots is used as a cure for Sarcoptic mange in sheep and goats. It is closely allied to *D. Oliveri* Schweinf and its var. *kilimandscharicus* Taub. ex Bak., an Abyssinian plant which extends through Uganda and Kenya into Tanganyika and is apparently common in Masailand.

D. pseudopachyrhizus Harms, has roots used not only as a soap substitute but as a fish poison. It is local but widespread in low-rainfall areas in East Africa.

A very local but widespread Cucurbit throughout East Africa, *Sphaeroscyos sphaericus* (E. Mey.) Hook. f. var. *tomentosus* Cogn., has roots and fruits which are used as a soap substitute. It does not appear to have been chemically investigated, but as three other genera of the Cucurbitaceae have been recorded as containing saponins this might prove to be another.

Other East African plants known to contain saponins but not yet recorded as being used as soap substitutes are:—*Albizzia anthelmintica* Brongn., *Cardiospermum helicacabum* L., *Cucumis metuliferus* E. Mey. ex Schrad., *Helinus ovata* E. Mey., *Hibiscus Sabdariffa* L. and *Xysmalobium undulatum* R. Br.

On the other hand, *Grewia Forbesii* Harv., *Pretrea zanguebarica* J. Gay, the Simsims, *Sesamum angolensis* Welw., *S. angustifolium* Engl. and *S. orientale* L., used as soap substitutes, have none of them been recorded as containing saponins although they are mucilaginous. It may therefore be useless to investigate these as possible sources of commercial saponin for fire extinguishers.

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THE FEEDING OF COTTONSEED TO PIGS

By M. H. French, M.A., Ph.D., Veterinary Laboratory, Mpwapwa, Tanganyika Territory

In the Annual Report of this Department for 1937, page 95, I reported upon the digestibility of cottonseed when fed to pigs and made the following comments:—

"Cottonseed is not normally regarded as a pig food but the value of this product for all classes of stock has been under investigation for a number of years and it seemed advisable to publish these figures. Cottonseed has been fed to pigs by this Department in various experiments and in one case to a mature female for a period of six months without any other type of food, with no symptoms of poisoning. It seems therefore that in certain instances cottonseed could form a valuable supplement for brood sows, but only small quantities should be tried because of the many reported instances of gossypol poisoning in swine following the feeding of cottonseed meal or cake."

In the digestibility trial recorded two 200–250 lb. pigs were fed a ration composed of equal parts of whole cottonseed and rice polishings for a period of three weeks with no untoward results. It was concluded that "when compared with sheep, pigs extract only half the feeding value of cottonseed. The low energy value of cottonseed for pigs barely makes the risk of poisoning worth while. It must certainly be used cautiously and in very small quantities".

All writers on animal nutrition stress the toxic nature of cottonseed or its cake when fed to pigs and the care required in feeding such foodstuffs has been summed up by Henry and Morrison (1936) as follows:— "Cottonseed meal or even cottonseed can be fed with safety in limited amounts and in properly balanced rations to dairy cows, beef cattle, sheep and horses. However, practical experience and scientific trials alike show that when injudiciously fed, animals are poisoned by these feeds. Cottonseed meal is most poisonous to swine. When cottonseed forms as much as one-third of the concentrates fed to pigs, they thrive at first, but after a few weeks they may become sick and die. Restricting the allowance of meal, keeping the animal on pasture, supplying succulent feeds, or souring the feed may help, but no uniformly successful method of feeding cottonseed meal to swine has yet been found." Later Morrison states that "Pigs thrive at first on the meal, but often in from four to six weeks some die—not all, as a rule—but so many that all possible profits from the use of this feed are lost. Some few feeders continue to use the meal, experience enabling them to avoid most of the losses. If cottonseed meal is not fed continuously for over 40 days or does not form over one-sixth to one-seventh of the ration (which is all that is needed to balance it), and if the pigs are freely supplied with green forage or grazed on pasture, the risk from this feed is lessened". Morrison then quotes Burns' results "that it is not advisable to feed more than 0.5 lb. of cottonseed meal daily per 100 lb. liveweight to any class of hogs for a very long period, and if the meal is to be fed for quite a long time, then it is best not to feed over 0.35 lb. daily per 100 lb. liveweight".

A brief review of the available literature on cottonseed poisoning in pigs shows that the toxicity varies between the results of individual workers and with the nature of the ration fed. Withers and Carruth (1915), when feeding one part of cottonseed meal with three parts of maize meal, record that death generally ensues in from five to seven weeks, although some pigs have been fed a year or more without fatal results". In a later experiment they mention that six out of nine pigs, fed the above mixture at the rate of 4 lb. per 100 lb. liveweight, died between the 35th and 57th days. The initial weights of the pigs varied from 75 to 150 lb. and all the smaller pigs died. Rommel and Vedder (1915) point out that cottonseed poisoning in pigs may be either acute or chronic, and state that in acute poisoning death takes place with little warning but that "In the chronic form fatal results may not occur for a considerable time. The symptoms persist if the feed is not changed, and the pig appears to develop a certain degree of immunity to the effects of the disease. His condition, however, is continually, though slowly, declining. Pigs suffering from this form of the disease may live for a year or more on a cottonseed ration". They state that symptoms of poisoning (diarrhœa, staring coat, paralysis and shortness of breath) may appear any time after three weeks of feeding and death frequently occurs with very little warning. Many other instances can be found in the literature indicating that death may take place a month or more after feeding cottonseed meal to pigs.

and recently Binns (1938) recorded deaths in pigs which he attributed to poisoning by whole cottonseed.

It now appears that the toxic principle of cottonseed is gossypol (Withers and Carruth (1915) and Schwartze and Alsberg (1924) and that toxicity varies between samples from different districts. The mode of action has not been worked out, but there is an undoubted relationship between diet and susceptibility to cottonseed poisoning. It has been shown by various workers that iron salts, lime, adequate protein, animal proteins, and green foods all help to minimize toxicity, whilst in many of the reported poisonings a very unbalanced or poor ration has been fed.

In view of these constantly repeated statements that cottonseed is poisonous to pigs, the fact that a pig has been fed for six months without any serious troubles arising and the very important part that cottonseed could play in pig dietaries in this territory if it were not toxic, it was decided to try the effects of cottonseed in the rations of fattening pigs. For this study three separate groups of pigs from mixed litters were used.

Trial No. 1

The feeding of cottonseed was tested first on pig 35, an entire runt weighing 60 lb. at four months old. This pig was put on to a ration (N) containing no proteins of animal origin and was given a small quantity of fresh lucerne every second day. As soon as he would eat up his food cleanly, small and increasing amounts of cottonseed were added to his ration so that after four weeks he was eating 20 per cent cottonseed. The cottonseed content was kept at this level for the next five weeks but the pig gained only 27 lb. so the cottonseed level was reduced weekly until it formed only 9–10 per cent of the ration. The liveweight curve showed a marked slowing down during the period the pig received 20 per cent cottonseed and showed a concave instead of the normal convex surface to the time axis. Once the percentage of cottonseed in the ration fell below 13.5 per cent the rate of liveweight gain showed a marked increase.

Unfortunately this pig was castrated by mistake and was then turned over for pork. As he had shown no symptoms of poisoning other than the slow rate of fattening he was not carefully examined for lesions after slaughter but nothing unusual was observed to cast doubt upon the fitness of the carcass for human consumption. It appeared from this pig's liveweight curve that cottonseed slowed down the rate of fattening and that this retardation was very marked when cottonseed formed over 13.5 per cent of the total ration.

Five other pigs were then put on to the individual feeding technique, and Table I gives the compositions of the different rations used.

TABLE I
COMPOSITIONS OF RATIONS

	Ration H			Ration N			
	H	H1	H2	N	N1	N2	N3
Maize meal ..	52	52	46	57	52	47	42
Rice polishings ..	20	20	20	10	15	15	15
Cowpea meal ..	10	—	—	10	—	—	—
Cake	10	10	10	20	20	17	15
Meat meal ..	5	5	3	—	—	—	—
Lime	2	2	2	2	2	2	2
Salt	1	1	1	1	1	1	1
Cottonseed ..	—	10	18	—	10	18	25

Pig 30 was given 1¼ lb. fresh lucerne daily and fed ration H until 70 lb. liveweight. He was then fed 10 per cent cottonseed (H 1) until 102 lb. when the amount was increased to 18 per cent. This pig grew slowly throughout the experiment, and eight weeks after cottonseed feeding commenced he went off-feed, showed a listless condition with laboured breathing and a high temperature for two days and then died.

Pig 31 was fed exactly as pig 30 but had 1¼ lb. fresh lucerne daily, he made better rates of liveweight increase, but six weeks after the cottonseed feeding began he died in exactly the same way and showing the same symptoms and post-mortem lesions as pig 30.

Pig 33 had lucerne only every second day but was otherwise fed as above. He grew slowly like pig 31 but six weeks after cottonseed feeding began (i.e. whilst he was still only getting 10 per cent cottonseed) he died in exactly the same way and with the same symptoms and lesions as the two previous pigs.

Pig 32 was fed on 1¼ lb. lucerne with ration N. Cottonseed, at 10 per cent of the total ration (N 1), was fed from 70 lb. This pig died suddenly, four weeks after starting on the cottonseed ration, during my absence. No symptoms were seen but the boy in charge reported difficult breathing. Post-mortem examination showed pneumonic lesions in the lungs and enteritis.

Pig 34 was fed as pig 32 but received one quart of separated milk daily. From 70–105 lb. liveweight the ration (N 1) contained 10 per

cent cottonseed, from 105–140 lb. 18 per cent cottonseed, and from 140 lb. onwards it contained 25 per cent cottonseed. Fairly satisfactory liveweight gains were made until the cottonseed proportions reached 18 per cent when the rate of fattening was slowed down, and a much greater slowing down took place on the 25 per cent cottonseed mixture so that liveweight become stationary two weeks after the cottonseed level reached 25 per cent. After four weeks on 25 per cent cottonseed the ration was changed back to 18 per cent but two weeks later the pig was ill, with fever, respiratory distress, weakness and no appetite. He was killed as unlikely to recover, and post-mortem examination showed gastritis, enteritis, and lung lesions as above.

I am grateful to Mr. A. H. Milne for the above post-mortem examinations, and he also eliminated the possibility of any infectious disease, such as East African Swine Fever, by inoculating blood from pig 34 into two weaner pigs without causing any untoward symptoms.

Trial No. 2

A fresh start was made with four more pigs from two litters, and the larger quantities of cottonseed were not fed until the pigs had reached a more advanced stage of fattening than in Trial 1. The rations fed are shown in Table II and are different from the ones used above:—

TABLE II

COMPOSITIONS OF RATIONS

	Ration K			Ration I	
	K	K1	K2	I1	I2
Maize meal ..	59	51	51	54	50
Wheat bran ..	15	15	15	30	30
Meat meal ..	8	6	6	3	2
Cowpea meal ..	15	15	10	—	—
Lime	2	2	2	2	2
Salt	1	1	1	1	1
Cottonseed ..	—	10	15	10	15

Pig 37 was fed on the recently published (1942) sliding scale of protein feeding up to 90 lb. and was then put on to 10 per cent cottonseed (Ration I1) until 150 lb. liveweight was reached when the level of cottonseed feeding was increased to 15 per cent (Ration I 2). This pig grew satisfactorily, but at a slower rate and with a greater food consumption per lb. liveweight increase than a pig fed the same ration without cottonseed. Breaks occurred in the liveweight curve at 170 and 200 lb. The pig never appeared ill and was never off food but, when slaughtered at 220 lb. liveweight, black patches were seen in the intestines, which also showed a slight catarrhal inflammation, and the lungs showed a number of pneumonic lesions.

Pig 39 received Ration K with lucerne *ad lib.* until 90 lb. liveweight. Cottonseed was then introduced into the ration and 10 per cent was fed until 150 lb. liveweight was reached, when the quantity was increased to 15 per cent. Breaks, due to a slowing down in the rate of liveweight increase, occurred in the liveweight curve at 150, 175 and 185 lb.

Except for the slow rate of growth and poor rate of food conversion this pig showed no untoward symptoms. After slaughter black patches were seen on the intestines, a small part of the stomach showed gastritis, there was a certain amount of catarrhal inflammation of the alimentary tract and pneumonic lesions in the lungs.

Pig 41 was fed exactly as in the case of pig 39. No breaks occurred in the liveweight curve but the rate of liveweight increase was below normal and the economy of food conversion was nearly as bad as for pig 39. No symptoms of poisoning were seen during life but after slaughter there were black patches suggestive of chronic enteritis together with areas showing slightly red patches in the intestines. Catarrhal inflammation of the gut was fairly widespread, there was gastritis, and pneumonic lung lesions.

Pig 40 received 10 per cent cottonseed from 70 lb. liveweight, 15 per cent when it attained 120 lb. The liveweight curve showed breaks at 127, 139, 174 and 189 lb. whilst it remained about 200 lb. for three weeks. The average rate of growth was very slow, as would be expected from the above stationary points on the liveweight curve, and the rate of food conversion was very poor indeed. No other toxic symptoms were seen until after the animal was slaughtered. Enteritis and black patches suggestive of old chronic enteritis with a catarrhal inflammation of the intestines were seen. There was also a gastritis and lung pneumonic lesions.

The slow rates of growth and poor rates of food utilization in the above cottonseed-fed pigs are summarized in Table III, where the corresponding figures for pigs 36 and 38 are given. Pig 36 consumed Ration I without cottonseed and pig 38 Ration K.

TABLE III

RATION OF GRAIN AND FOOD UTILIZATION (LB.)

Pig No.	36	37	38	39	40	41
Ration	I	I with cottonseed	K	K with cottonseed	K with cottonseed	K with cottonseed
Initial weight	63·5	64·0	60·5	61·5	65·0	64·5
Final weight	206·0	201·0	207·0	201·0	202·0	200·5
Gain	142·5	137·0	146·5	139·5	137·0	136·0
Number of days	95	104	102	133	158	110
Gain per day	1·50	1·32	1·44	1·05	0·87	1·24
Food consumption	491	552·25	484·5	631·50	640·25	570·25
Food consumption per lb. gain	3·44	4·03	3·31	4·53	4·67	4·20

Trial No. 3

In this third trial six pigs were fed together until they were 100 lb. liveweight on Ration I possessing a sliding scale of protein content. At this weight they were divided into three comparable pairs. The first pair served as controls and one pig continued on this standard ration, but pig 55 was killed to see whether any post-mortem abnormality was present at the commencement of the cottonseed feeding tests. The other control was killed at the same time as the cottonseed-fed pigs. The second pair were fed the control ration with 10 per cent of cottonseed added from 100 lb. liveweight. The third pair received the control ration with 10 per cent cottonseed added for two weeks and thereafter 20 per cent.

TABLE IV

RATES OF GAIN AND FOOD UTILIZATION (LB.) FROM 100 LB. LIVEWEIGHT

Pigs Nos.	56	54 and 57	58 and 59
Ration	Control	10 per cent cottonseed	20 per cent cottonseed
Initial weight	97·0	102·25	101·50
Final weight	189·0	190·00	183·50
Gain	92·0	87·75	82·00
Number of days	69	62	84
Gain per day	1·33	1·41	0·98
Food consumption	353·25	356·00	432·00
Food consumed per lb. live weight increase	3·84	4·06	5·27

Feeding 10 per cent cottonseed slowed down somewhat the rate of liveweight increase and reduced appetite so that, for the sake of comparison, the control pig had its food supply restricted to keep its liveweight to just below that of the 10 per cent cottonseed-fed pigs. The feeding of 20 per cent cottonseed still further reduced the appetite and slowed down the rate of fattening, and often the pigs picked out the whole cottonseeds and refused to eat them. The feeding results are summarized in Table IV.

These figures clearly indicate the great retarding influence of 20 per cent cottonseed in the ration.

Neither the 10 per cent nor the 20 per cent cottonseed pigs showed any symptoms of poisoning, other than the tendency to leave the cottonseed uneaten but, at slaughter, careful post-mortem examinations were made by Mr. J. K. H. Wilde, Veterinary Research Officer, who also examined the various lesions microscopically. In the cottonseed-fed pigs, pneumonic lesions of the lungs, slight inflammation of the mucous membrane lining the fundus of the stomach and sometimes enteritis were found, but the lesions were not so pronounced as in the previous trials.

The interesting point about the foregoing results is that the severity of the effects following cottonseed feeding decreased from the first to the third trial. Different lots of cottonseed were used in each and it is well known that

cottonseed toxicity varies considerably. The pigs in the first trial were smaller (70 lb.) than those in the other trials at the time cottonseed feeding was started and this may also be a contributing factor. Certainly four out of five pigs in Trial 1 died and the fifth was slaughtered when typical severe symptoms had developed. The symptoms in this first trial differ from those described by Rommel and Vedder (1915) in that no diarrhœa nor staring coat were observed. Further, in these tests, no dropsical condition nor paralysis were produced. On the other hand, lesions of the alimentary tract and lungs were found but, whereas Rommel & Vedder merely report oedematous lungs, pneumonia was present in the Mpwapwa pigs, causing difficult respiration before death.

In Trial 2, the pigs were 90 lb. when cottonseed feeding commenced but instead of dying these pigs suffered significant set-backs in their rates of fattening and, when killed, all showed lesions of the lungs and alimentary tract similar to those found in the first trial. The rate of cottonseed feeding was lower and the pigs were older than in the first trial and these two factors may account for the less severe symptoms but no information is available on the differences in toxicity of the cottonseeds used.

In Trial 3, the pigs were just a little older than in Trial 2. One pair were fed cottonseed at the same rate as in Trial 1, and the others at a lower rate. The rates of liveweight increase, particularly for the pair on the higher cottonseed ration, were reduced. Lesions of the lungs and alimentary tract were again amongst the post-mortem findings and were definitely more marked in the pigs fed the greater amount of cottonseed.

It is interesting to set out the rates of cottonseed feeding per 100 lb. liveweight:—

Live weight	Trial 1	Trial 2	Trial 3	
			1st pair	2nd pair
Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
70	0·47	—	—	—
80	0·48	—	—	—
90	0·49	0·45	—	—
100	0·79	0·42	0·55	0·55
110	0·80	0·40		
120	0·83	0·39	0·46	0·91
130	0·83	0·42	—	—
140	0·79	0·41	0·40	0·71

The rates of feeding are all above the limit of 0.35 lb. cottonseed per 100 lb. liveweight reported by Burns, and the results show that cottonseed at these rates is not suitable for fattening pigs. There is a serious risk of causing death and even if fatal results are not produced the rates of liveweight increase and the rates of food conversion are reduced so that any possible saving in the cost of the ration will be more than offset by the greater amount of food eaten during the fattening period, the greater overhead costs and the slower rate of turn-over.

Conclusion

Cottonseed cannot be recommended as a food for fattening pigs because it reduces the appetite, slows down the rate of fattening and increases the amount of food required to form 1 lb. of liveweight increase. In larger amounts it will cause more pronounced set-backs in the rate of fattening and may even prove fatal.

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The problem of dedicating lands to their highest use is not the responsibility of any one profession; it is an undertaking which calls for the co-operative efforts of biologists of all classes, of geologists, soil specialists, engineers, economists, sociologists and legislators; and lastly it calls for understanding and approval by the general public.

G. A. Pearson quoted in *Herbage Abstracts.*

DERRIS CUTTINGS

These are available in large quantities at the East African Agricultural Research Station, Amani, price Sh. 20 per 1,000 cuttings, carriage forward to purchaser's station. Orders should be sent to the Director, with an indication of the date the cuttings are required and the name of the station to which they should be consigned.

NOTES ON ANIMAL DISEASES

XVI—BOVINE BRUCELLOSIS

Compiled by the Veterinary Department, Kabete, Kenya

Contagious forms of abortion occur in cows, sows, goats, mares and ewes. Bovine brucellosis is the name given to that form of contagious abortion of cattle caused by the specific bacillus, *Brucella abortus*. In Kenya, as in most parts of the world, contagious abortion is widespread. In Europe and America another organism, a protozoan known as *Trichomonas abortus*, also causes abortion in cattle; but in spite of a constant search this organism has not yet been found in Kenya. Abortion of sows may be caused by *Brucella abortus* or a related form, *Brucella suis*. Contagious abortion has not, however, been recognized in sows in Kenya. Contagious abortion in sheep in Europe by *Vibrio fetus* and contagious abortion of mares due to an organism of the typhoid-paratyphoid group, *Salmonella abortivo-equinus*, are likewise not recorded from East Africa. In Malta, *Brucella melitensis* occurs in goats, but is of greater significance as the cause of Malta fever in man than as the cause of abortion in goats.

The organism *Brucella abortus* is a small bacillus which can be cultivated on laboratory media. It is pathogenic for cattle, swine, goats, sheep, horses, guinea-pigs and man, but under natural conditions it is rarely the cause of disease in animals other than cattle, swine, horses and man. In the horse, it is found in chronic septic lesions, such as fistulous withers. In man, it, like the related *Brucelli melitensis*, gives rise to recurring bouts of fever associated with headache, the condition usually being called undulant fever. Only the bovine disease will be described in these notes.

Symptoms.—It is most unusual for any symptom to be shown other than actual abortion. This may occur at any stage of pregnancy, but is most frequent between the third and sixth months of gestation. A certain percentage of pregnant cows become infected without actually aborting and these, as well as those which have aborted, may develop into carriers.

Abortion is frequently followed by retention of the after-birth and this may lead to septic metritis and death or sterility. The actual infection with *Brucella* is, however, rarely, if ever, the cause of death.

Diagnosis.—Since contagious abortion is the most frequent cause of abortion in cattle, its presence should always be suspected when a cow aborts and if, during a short period, more than one animal in a herd aborts, a definite diagnosis should always be obtained. If the foetus can be delivered at the laboratory within 24 hours of being dropped, a diagnosis can be made by a bacteriological examination of the stomach contents. The more usual method of determining whether an animal is infected is, however, by the agglutination test.

The agglutination test reveals the presence, in the blood serum of a recently recovered or carrier animal, of immune bodies which cause the bacteria in a weak suspension to stick together in clumps. The suspension is prepared by growing the organism on laboratory media and by washing off the growth with saline. Since at the time of abortion a cow may not have developed immune bodies, a period of ten days should be allowed before collecting a sample of blood for the test. Blood should be collected from the jugular vein into a dry sterile bottle, the usual precautions being adopted to prevent the entrance of extraneous organisms.

Without undue shaking the blood should be placed in a cool place to clot and should then be dispatched to the laboratory.

If there is water in the bottle the serum will be haemolysed, or if extraneous bacteria enter the bottle, the sample may be haemolysed or even badly decomposed. Haemolysis or heavy contamination may render the sample unsuitable for testing. Under field conditions, particularly when a large number of cases are being bled, the entrance of a few bacteria is almost unavoidable, and in a warm climate it is, therefore, essential that the sample be received at the laboratory as soon as possible. If it is necessary to hold the samples before dispatch, they should be placed in a refrigerator as soon as clotting has occurred and should be left there until they are sent off.

Spread of Infection.—Following abortion the causal bacteria are present in enormous numbers in the discharges and they continue to be present in the vagina for periods up to two months after abortion. As the uterus resumes its normal non-pregnant form, the bacteria disappear from the genital tract but become localized in the udder and its associated lymph glands. It is rather unusual for a cow to abort

more than once, although in carrier animals the bacilli reappear in the uterus and its discharges during subsequent pregnancies.

Carrier animals also excrete the bacteria in their milk during the first 2–3 months of the lactation.

Cows commonly pick up infection either by eating grass or other foodstuffs contaminated with discharge or by the introduction of bacilli into the eye. The causal bacteria may be present in the dry dusty atmosphere of the cow-house, or discharge from the vagina, on the tail of an infected cow, may be flicked into the eye of a healthy animal.

Less frequently, cows may be infected at service. A bull serving a healthy cow a short time after he has served an infected cow may introduce the bacteria on his penis. The bull himself rarely becomes a carrier. Although male animals may contract infection in a symptomless form, relatively few instances are known of the bacteria becoming permanently localized in the testicles. Infection of the testicle leads to the formation of a cold abscess and bacteria are present in the sperm.

Cases of undulant or Malta fever in man are due either to skin infections contracted at the time of removing a retained afterbirth or to drinking unboiled, infected milk. Herd milk that is the mixed milk from a herd of cows, some of which may be carrier animals, is less dangerous to human beings, presumably because of dilution and the presence of immune bodies in some of the milks, than the milk of a single infected cow.

Methods of Control.—There are two main methods of control, by testing and segregation and by vaccination. Ideally the former method only should be used; but it frequently happens that segregation is practically or economically impossible.

If contagious abortion has been confirmed on a farm, samples of blood should be submitted from a proportion of the herd. An outbreak may occur following the abortion or calving of a newly-introduced cow. A sample from this cow and from the others of the same batch or from others obtained from the same source should then be included. If no other positives are found a whole herd test should be made.

If, however, the return indicates that there are a number of reactors amongst those examined, it may be assumed that a fairly large number of animals is affected.

The further action to be taken will depend upon the incidence of reactors and upon the facilities available for segregation. If only a low proportion of cows is positive it may be possible to adopt the ideal method of disposing of reactors and removing the clean herd to new pasture. Buildings that may have become infected should be disinfected and new routes to the dip and new watering places should be used. *Brucella abortus* will probably not survive for more than three months on grazing, but when possible it is recommended that a period of six months be allowed before contaminated pastures are used by clean stock. The herd should be tested at 2–3 monthly intervals, and if no positive cases occur over a period of nine months, it may be considered clean. All new purchases should, of course, be tested before admitting them to the herd.

When the incidence of infection is high, control by segregation is feasible only when the farm is extensive and two sets of buildings are available. Under these conditions the clean animals should be moved to clean land and clean buildings, and the herds run as completely separate units with different bulls. Calves from the infected herd may be moved to the clean herd a few weeks after weaning without danger and hence the infected herd will ultimately disappear.

Vaccination may also be employed to control wastage when the proportion of infected animals is high. Animals are inoculated with a live vaccine, the object being to cause a mild infection at a time when the animal is non-pregnant and cannot, therefore, abort. Infection is followed by immunity which, although not always absolute, is usually sufficient to prevent abortion if a period of at least two months is allowed to elapse between vaccination and service.

The objection to vaccination lies in the fact that some vaccinated animals retain a residual infection in the udder and its lymph glands. The organisms used in the vaccine are of an avirulent strain and yet there are, of course, obvious hygienic objections to the occurrence of potentially dangerous bacteria, even when attenuated, in a milk supply. Animals harbouring the organism, moreover, may continue to react to the agglutination test and thus it is difficult to change over in the course of time to control by testing and segregation.

Recent experiments in America suggest that these dffiiculties may be overcome by what is known as "calf-hood" vaccination with an avirulent strain of organism. Calves are vaccinated when 4–8 months old, and one particular

strain of the organism, strain 19, has given most promising results, establishing infection without a lodgment in the udder or genital system. An immunity covering the first two pregnancies is obtained, and six months after inoculation a positive agglutination is found in only about 10 per cent of the vaccinated animals.

When vaccinating an infected herd by the ordinary method, all non-pregnant, adult, female stock should be inoculated and they should be kept from the bull for a period of at least two months afterwards. In-calf animals should be vaccinated after they have calved and in the past it has been customary to vaccinate heifers in batches 6–3 months before putting to the bull. A number of farmers are now, however, vaccinating their heifer calves when about six months old, and the results of this treatment are being watched with interest.

SHORT-TERM RUBBER PLANTS*

Tropical rubber production has always depended on long-term perennial plants. Wild rubber has, in Africa, been obtained from members of the family *Apocynaceae*, especially the lianes and shrubs of the genus *Landolphia*, while the cultivated rubbers have been trees belonging to the family *Euphorbiaceae*. The present reduction in supplies of rubber from the latter source has naturally directed attention to the possibility of obtaining rubber from plants that can be grown quickly and utilized at a comparatively early age. These requirements limit consideration to plants that are herbs or small shrubs.

In the search for such plants the Soviet Union has taken the lead. In 1931–1934 thirty expeditions were organized in the Soviet Union to search for rubber-containing plants. Over a thousand species were examined, of which 609 were found to contain rubber or rubber-like substances. Only a few of these were thought suitable for cultivation, including guayule (*Parthenium argentatum*), kendir (*Apocynum venetum*), vatochnik (*Asclepias cornuti*) and some plants belonging to the genera *Scorzonera* (tau-saghyz) and *Taraxacum* (krym-saghyz and kok-saghyz). Of these by far the most important, both actually and potentially, are the first and the last, both members of the family Compositae, to which belong the familiar dandelion (another *Taraxacum*) and daisy.

Guayule, which is a shrub, has already received a good deal of publicity because it has been established as a commercial crop in California for some years. An immense expansion will now take place under a government scheme just sanctioned for production in the south-western U.S.A. The home of the plant is in Mexico, between latitudes 20 and 28° N., at altitudes of 3,000 to 7,000 ft. in a dry climate. The soils it favours contain a large percentage of lime. The rubber is contained in isolated cells mostly in the bark of the roots, stem and branches, but since latex cannot be induced to exude, the whole plant must be mechanically treated.

Indications are that good crop land will prove most suitable to guayule production. Rainfall of only eight to twenty inches a year seems sufficient for normal yields, provided that little or none of it occurs during the summer season, when rains discourage rubber accumulation in the plant. Except for certain seedling diseases and root rot in some areas, the plant appears to be rather resistant to insect and disease enemies. The guayule plants are cultivated like corn, four times the first year, three times the second and third years, then twice the fourth year. Harvesting is confined to the so-called dormant period when the rubber content of the plant is greatest.

Research financed by private enterprise has isolated strains with a relatively high rubber content that are now in cultivation by highly mechanized methods. Seed germination seems naturally low, only about 5 per cent, but by treatment this can be improved until there are but few failures. It was at first stated that while rubber could be obtained at two years old four to six years was regarded as the best age. Later, as a result of selection and improved cultural treatment, young plants less than a year old were claimed to contain "6.3 per cent of pure caoutchouc on a bone-dry deleafed basis", a yield equivalent to 1,164 lb. per acre, and it was thought possible to produce as much rubber per acre in two years as was formerly counted on in four years. The latest reference available quotes the yield

* Compiled from *Industrial & Engineering Chemistry*, 1930, pp. 384-387, *Soils & Fertilizers*, Vol. 5 (2). pp. 47-49, 1942, and *Chronica Botanica*, Vol. 7 (3), p. 138, 1942.

of rubber at four years old as 20 per cent of the dry weight of the shrub, with a resin content of 16 per cent in the extracted rubber.

On harvesting the shrubs are pulled, chopped, thoroughly dried and crushed—all, like the planting and cultivation, by highly mechanised methods—before being conveyed to continuous-feed tube mills. After repeated disintegrating and washing of the plant debris the rubber agglomerates into pieces up to the size of a pea, which can then be separated by flotation. Laboratory analysis shows that by these methods only .25 per cent of the rubber present in the shrub fails to be recovered. When deresinated the rubber is said to be a perfect substitute for high-grade plantation rubber.

Attempts are being made to get seed of guayule for trial in East Africa, but the soil, climate and length of day in its native country being what they are, the chances of its being grown successfully in East Africa are not great.

Taraxacum kok-saghyz, the herbaceous plant producing most of the Soviet Russian natural rubber, is native at 7,000 to 8,000 ft. in the Tian-Shan. The cultivated plant fructifies at the end of the first year of growth, and may then be used for obtaining rubber, which is localized in the roots in the form of long filaments. Selection is proceeding with the object of transforming cultivated strains from fibrous-rooted into thick-rooted plants with high yields and an improved rubber content in the second year. The rubber is obtained by reducing the roots to a fine powder which is macerated in water. The rubber, which then separates out by gravitation, is of satisfactory quality, though not equal to *Hevea*. The record yield obtained is about 200 lb. of rubber per acre.

Although the natural habitat of kok-saghyz is on alkaline soils it will grow on soils with a pH as low as 4.5. In Russia germination is secured in 4–5 days instead of 40–50 by keeping the seed before planting at freezing point and well moistened. On mineral soils about 2 lb. is sown to the acre, and preferably after a crop that has received both organic and mineral manures. The best root growth is obtained on peat soils that have been limed. Careful cultivation is necessary, at first to keep weeds down and later to maintain good aeration.

The prospects of kok-saghyz being a satisfactory source of rubber in East Africa are probably negligible. None of the environmental factors of the areas in which it is native or successfully grown in the Soviet Union are available here. Over a hundredweight of seed has recently been sent by air from Russia to Minnesota, where it is expected to do well with an annual rainfall of 20 inches and a hard winter.

The second most promising rubber plant in Russia is *Taraxacum megaliarhizon*, which contains a very high-quality rubber, superior even to Hevea, but in only small quantities. It is disappointing to find that the 6 per cent content of the roots in the wild plant drops to less than 1 per cent in the cultivated.

In *Apocynum venetum* and *Asclepias cornuti* the rubber is localized mostly in the leaves, which may contain up to 10 per cent, apparently of rather poor quality. In the former plant the stems are cut twice a year and on the figures quoted the yield per acre may vary from about 20 to nearly 400 lb.

R.E.M.

Some months ago a certain industrialist spokesman [in India] said: "Nearly 70 persons out of every 100 have no higher occupation than agriculture or services dependent on agriculture".

The remark was unfortunate. Whatever else war does, it focuses attention on the absolute necessity for a strong national agriculture as a basis for every other action. The hunger of the factory worker and the hunger of his machine (for raw material) have both to be satisfied by agriculture.

Indian Farming.

Nations and even highly developed civilizations have gone to their sleep because of failure to safeguard their soils. It has been estimated that the United States has only seventy-five to one hundred years to go as a virile nation unless brave remedial measures are set up. Our country has a fatal earth disease.

M L. Cooke quoted in *Herbage Abstracts*

A rising standard of living cannot be based on a falling level of soil fertility.

Lord Hailey.

Science is not gadgets but a way of thought.

Australian Journal of Science.

NATIVE AGRICULTURAL IMPLEMENTS IN THE UGANDA PROTECTORATE

By D. R. N. Brown, B.A. (Cantab.), A.I.C.T.A.

The diversity and distribution of the agricultural implements used by a race may be expected to depend upon the agricultural history of that race, which in turn has been determined primarily by natural environment but modified by racial descent and contacts.

The Bahima of Ankole in the south-west and the Karamojong of the north-east of Uganda are descendants of Hamitic nomadic invaders and to this day are exclusively pastoral peoples, living with and upon their herds, their migrations being governed by availability of water and pasturage. The areas they occupy are better suited to extensive cattle rearing than to crop production and their diet consists mainly of milk and blood, occasionally supplemented by meat derived from the herds and wild fauna, together with beer for which they barter with cultivating neighbours. They have no agricultural implements of their own manufacture.

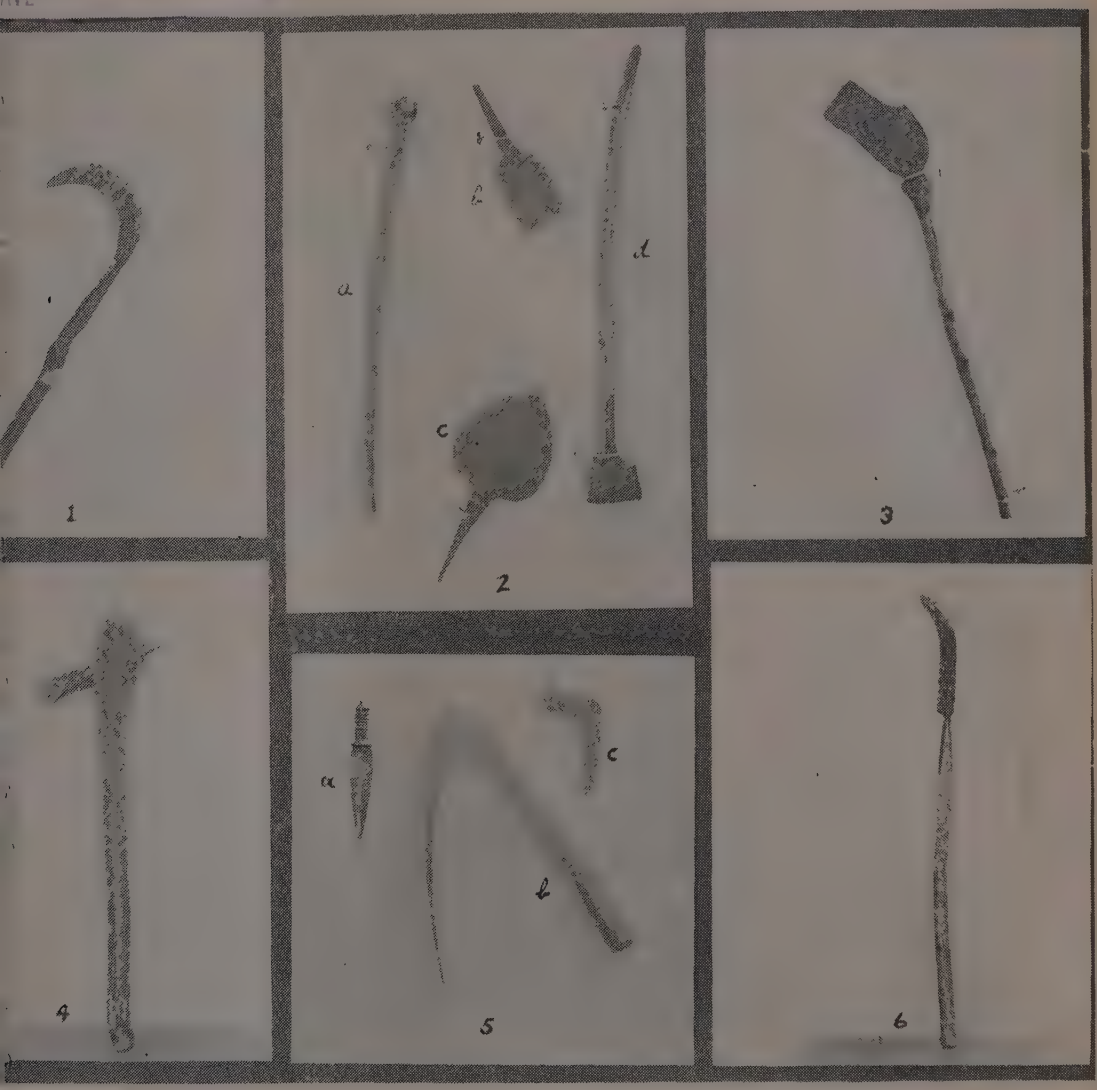
The territory occupied by the Bantu peoples comprises a belt stretching along almost the entire northern shores of Lake Victoria and includes the foothills of the mountains Elgon and Ruwenzori. This is a region of heavy natural forest broken up by papyrus-filled swamps. Clearing of the forest for cultivation has resulted in the development of large areas of elephant grass (*Pennisetum purpureum*) which is largely instrumental in preserving soil fertility and which is burned and cleared too frequently to permit redevelopment of the forest climax. The environmental factors, including increasing population, of this lake region have imposed a more or less settled agricultural system upon the people, its basis being the plantain garden, in and around which are grown the food crops and latterly cash crops, such as cotton, coffee and tobacco. The Bantu peoples in Uganda have always been predominantly tillers of the soil and as the heavy vegetational cover of their country does not lend itself to ploughing, they are dependent almost entirely upon the hoe for cultivation. They have developed axes and heavy slashing implements for clearing the bush and various special tools for dealing with the plantain crop.

Tribes of Nilotic or Nilo-Hamitic affinity occupy the central, northern and north-western parts of Uganda. These regions have on the whole a drier climate than that of the Lake belt, with a severe dry season. Tall-grass—low-tree savannah as described by Tansley and Chipp (1926) covers the greater part, but considerable areas have been more or less denuded of trees. This drier and more open country is less able to sustain intensive tillage but supports large herds of cattle. Perennial crops, such as bananas and coffee, are ill-adapted to this environment, though short-term crops such as millets, groundnuts, simsim and beans do well. Probably in the past all the people in this region were pastoral but also cultivated grain. The great rinderpest epidemic of 1890 must have caused a major change in the mode of life of some of the tribes, necessity compelling them to till where they had previously herded: also trypanosomiasis decimated the herds of the tribes of the Nile valley. In some localities cultivation is assuming much greater importance than hitherto, yet in others reluctance to cultivate or lazy methods are frequently found. Driberg (1923) expresses the opinion that the Lango are at heart a pastoral people and that many of the crops now grown by them were obtained during raids upon their neighbours. Stigand (1923), describing the Madi country, states that the uplands were stocked with cattle but not the lowlands. Quoting Baker he suggests that formerly cattle were also numerous in the lowlands, but their numbers were greatly reduced by trypanosomiasis and other epidemics. All the Nilotic tribes relied entirely upon the hoe for cultivation in former times but, as will be seen later, some have recently taken with great enthusiasm to the plough. They also have axes, slashers, small hoes for intercultivation and knives of many shapes and sizes for harvesting grain.

It is convenient in describing the implements to adopt a classification based upon the order in which the tools are used: (1) those for clearing bush and grass for cultivation; (2) hoes and other digging implements; (3) ploughs; (4) harrows and rakes; (5) planting implements; (6) those of aid in weeding and intercultivation; (7) harvesting tools; (8) special purpose implements. A final section will be devoted to manufacture, trade and ceremonial uses of agricultural implements.

SUPPLEMENT

ee "Native Agricultural Implements in the Uganda Protectorate"—Vol. VIII, No. 2, pp. 96–100.



IG. 1—*Ekisalizo*. Long-handled knife for cutting plantain bunches.

IG. 2—*a* and *b*. Detached blade and shaft of former type of native-made hoe used by Lugwara and Kakwa tribes of West Nile district. *c* and *d*. Detached blade and shaft of modern type of native-made hoe used by Lugwara tribe.

IG. 3—Slasher used by West Nile tribes. *Angole* (Lugwara), *Pere* (Alur).

IG. 4—Native-made axe.

IG. 5—*a*. Lugwara women's knife (*Eli*); *b*. Lugwara wooden hoe (*Longudi*); *c*. Alur women's knife (*Pala*).

IG. 6—Long-handled slasher used by Bantu tribes. *Omukutu* (Lunyoro).

FIG. 7
Omukutu in use.

FIG. 8
Ekisalizo in use.

FIG. 9
Type of Madi hoe described by Stigand.

Implements used in Clearing Bush and Grass

The employment of fire to assist in clearing thick vegetation prior to cultivation is universal throughout the Protectorate. Grass and shrubs which the fire does not destroy are cut with slashers of various designs. An implement commonly utilized by the Bantu is similar to the English billhook as regards the blade; the shaft is three or four feet long and the blade has a spike-like tang which is driven into the end of the shaft. Vernacular names, *omuhoro* (Lutoro, Luiru, Lukigezi), *akambi* (Luganda). Similar work is done in Bunyoro with a straight-bladed long-handled knife, *omukutu* (Lunyoro), or with a slasher with a semi-circular blade, *omukutu kakondo* (Lunyoro), both of which have a tubular base to the blade into which the shaft is inserted. From the Bagishu, who are Bantu people with little if any Hamitic blood, comes the record of a cutlass, *imbalu* (Lugishu). This was like a heavy two-edged sword about eighteen inches long, having a central ridge and fitted with a shaped handle some six inches long. Besides its use for clearing bush the *imbalu* was employed for pruning plantains. An implement in use amongst the Nilotic peoples in the West Nile District consists of a leg-of-mutton-shaped blade, the tang of which is set at an agle to the blade and imbedded in the end of a shaft about two and a half feet long, *angole* (Lugwara), *pere* (Alur). The blade has only one cutting edge, that without the neck, but forehand and backhand strokes are made alternately by turning over the wrists. Amongst the Bantu tribes particularly, the shop-bought cutlass is gaining favour as its tempered steel gives a sharper edge and greater wearing qualities than the local product.

The native-made axe with slight variations in shape occurs amongst all tribes and is used to fell trees which are too heavy for the various slashers, and to cut firewood and poles. The blade is a piece of metal shaped like a wedge or an elongated tomahawk and sharpened at the broader end to give a cutting edge one to three inches long. The tapering narrow end is fitted into a slot in a club-shaped handle some two feet long, *embaazi* (Luganda), *Endemu* (Lutoro), *empangu, endyamiti* (Lunyoro), *latong* (Acholi), *lei* (Alur), *ogara* (Lugwara). The axe of European design is infrequently encountered.

Hoes and Other Digging Implements

The hoe is employed in one design or another by all tribes who cultivate at all in Uganda. Amongst the Bantu peoples it has always been customary for the women to do the cultivation of food crops, the men concerning themselves only with economic crops. There is some evidence that long ago digging-sticks were widely used in Uganda. Bored stones which it is suggested were used as weights for such sticks have been found in several localities. Masefield (1941) notes that angled digging-sticks shod with iron spikes are employed by the Banyaruanda in Kigezi District for cultivating in small pockets of soil between the laval boulders where the hoe cannot penetrate. An entirely wooden hoe was utilized by the Bagishu before the introduction of iron smelting. The blade was shaped like a broad spear and was tied with banana fibre to the short arm of a natural crook, the longer arm, some two feet in length, being the handle. This hoe, *liitsu* (Lugishu), was made from a special tree and was used for cultivating banana plots. According to the doubtful memory of some of the old men the ribs of cattle also have been used as hoe blades. The Nlio-Hamitic Iteso appear to have done their scanty cultivation in the past with a wooden implement something like a spade, *akuta* (Iteso). This may bear some relation to the wooden hoe *okuta* mentioned by Driberg (1923) as being used by the nearby Nilotic Lango before iron was plentiful. The hoe popular with the Bantu women consists of a heart-shaped blade with a six inch tang which is tied by banana fibre to the shorter limb, some nine inches long, of a natural crook, the longer limb of which, about one and a half to two feet in length, is used as the handle. The men use a similar hoe with a slightly longer handle or the three and a half pound hoe of European design, having a ring to receive the handle. This design of hoe has gained greatly in popularity of recent years in Bantu districts, its durability commending it to the cultivators. The Bantu angle-hoe is used also by the Iteso, who have cultivated extensively only in recent years and have probably borrowed their hoe design from neighbouring Bantu tribes. The hoe used at present by the Lango is unique in Uganda in that the tapering tang, some six inches long, of the heart-shaped blade is tied in one straight line with the shaft, which is six or more feet long. Deep cultivation is impossible with this hoe, which is normally employed after the manner of a Dutch hoe. The operator either stands or kneels, in the latter position the hoe being grasped low down, held away from the body, and the strokes applied inwards. An interesting similarity is observed between this hoe and that used by the

Bari people of the Sudan, as described by Stigand (1923), who writes: "If one is fortunate enough to meet a Bari during one of his rare moments of work one may have an opportunity of seeing the mode of employment of the Bari hoe, the laziest hoe on earth. A small iron blade about the size of half a saucer [the normal heart-shaped blade soon wears to this shape—D.R.N.B.] is attached to a pole ten or twelve feet long. The labourer stands in a nonchalant attitude or reclines on a stick, looking in any direction but that in which he intends to hoe, holding the end of the pole and with the end of it resting on the ground some ten feet from him. He every now and again gives the pole a thrust which makes the hoe run along the top of the ground, scraping off the surface weeds and grass. He continues in this way until he has described a circle about himself, but as he scarcely ever looks at what he is doing some of the ground is left untouched. When he thinks he has done enough he scatters some grain on the scratched up surface of the ground and also on any spots in the vicinity which have not much grass on them and then leaves Nature to do the rest."

The style of hoe in use by the Nilotic Acholi and the related Jonam is identical, as their recent separation would lead one to expect. The blade is more or less heart-shaped, with a tubular process at the top into which a natural crook is inserted. The short limb of the crook to which the blade is affixed is one to two feet long and the long arm or true shaft is five or so feet long. This hoe is a much more powerful implement than the short-shafted crooked hoe of the Bantu.

Several designs of hoe are found amongst the tribes of Nilotic affinity in the West Nile and Madi Districts of the Protectorate. The Madi hoe formerly in use is described by Stigand as the heaviest and biggest he had seen anywhere in Africa. It was at that time used as a form of currency. By means of fibre the head was attached to a shaft identical with that now used by the Acholi. Nowadays a somewhat smaller model of this hoe is still used, but the Acholi-pattern hoe has almost completely replaced the earlier model for cultivating. The Madi in the south and also the Lugwara and Alur use the heart-shaped blade but with a straight handle. The shaft is often fashioned from Acacia wood and consists of some four inches of main stem in one piece with about three feet of a perpendicular side branch, the whole taking the form of a long-handled mallet; a slot is burned through the centre of the piece of main stem and the tang of the head is driven into this until firmly fixed and only about one inch projects on the head side. The European ring-hoe is not liked, as when the blade becomes half-worn the shaft prevents deep digging. The heart-shaped model on the other hand can be adjusted by moving the tang in the slot so that the hoe can be used successfully until all the metal is worn away. The Kakwa tribe of the West Nile District also use the mallet-headed shaft, and in modern times the heart-shaped blade obtained from traders. Formerly the blade of local manufacture was oblong with rounded shoulders, about eight inches long by five broad, with the tang similar to that of the trade design. Holes for receiving house-poles and for planting bananas or coffee are made by the Bantu tribes with a wedge-shaped or blunt spear-shaped blade attached to a pole. This implement *ekifumu* (Luganda), *ekirimyo* (Lunyoro) is also employed for prising out yams or banana stools.

Ploughs

The affinities of the Iteso indicate a remote pastoral history and it is more recently that they have taken to extensive cultivation. Their aversion to hand cultivation and their knowledge of the use of stock are illustrated by the extraordinary rapidity with which they have adopted ploughing. The introduction of cotton as a cash crop provided them with the incentive to wider and more rapid cultivation and the open nature of their country lends itself to ploughing. The number of native-owned ploughs in Teso District in 1924 was 232; in 1937 the number had increased to 15,388. Not only do the plough-owners use their implements for their own plots but a large hiring trade is in evidence. A usual payment for daily hire of plough, team and ploughman is Sh. 2 or its equivalent in work or kind. It is clearly in the interests of the plough-owner to do as much hiring as possible, and largely for this reason much of the ploughing seen consists of a shallow scraping of the top three or four inches of the soil. Also the plough may sometimes be hired out with a child as ploughman, which results in poor work. Marked enthusiasm for the plough has also been shown by the neighbouring Lango in recent years; they know a bad plough from a good one but, like the Iteso, do not always plough well. In the areas of sandier soils sheet-erosion is much assisted by shallow ploughing, as is gullying

by the all-too-frequent ploughing up and down slopes. In the Bantu country the plough has not achieved popularity, no doubt largely owing to the thick vegetational cover of the land; but other factors are the incidence of trypanosomiasis, which in some regions renders cattle rearing impossible, and the peoples' small knowledge of cattle except as capital.

Harrows and Rakes

A many-twigged branch of a tree carrying a log for weight is sometimes used by the Iteso as a harrow to cover in seed of small millet. The branch is dragged across the plot by two oxen. Another interesting use of their stock by this tribe is the consolidation of plots for grain by the feet of herds of cattle or goats, which are walked round and round over the tilled soil. A rake is employed by various peoples for collecting grass and other rubbish from plots in preparation for sowing. A tree branch with a fork having two or three prongs is sought and cut to give convenient shaft length, and whilst still green the prongs are bent and tied down to form a rake, *orukanduzo* (Lunyoro). Small sticks are sometimes tied across the prongs to give strength.

Planting Implements

The majority of crops in Uganda are planted by broadcasting or by hand-planting the seed after holes have been made with the hoe, so that tools of special use for planting are rare. As stated above, the *ekifuma* and *ekirimyo* are used in making holes for planting bananas and coffee. Cotton planting is done always by making shallow holes with a hoe or long pointed stick, dropping seed in by hand and covering it with soil with the aid of the foot. A simple but quite effective method of planting sweet potato slips in the mounds used for the cultivation of this crop is employed by the Madi and Lugbara peoples. The stalk of the slip is held against the point in the mound at which it is to be inserted and the notched end of a short thin stick is then pressed against the stalk about an inch from the free end. The stick is then thrust to the required depth into the mound, taking with it the bent stalk of the potato slip. The stick is then withdrawn, leaving the slip in situ.

Weeding and Intercrop Cultivation Implements

For weeding amongst broadcast crops where there is insufficient room for the hoe, and also for weeding in plantain gardens where the deeper cultivation of the hoe would be likely to sever the roots and cause severe bleeding, some of the Bantu tribes use a short spear-like wooden instrument, *oluti* (Lusoga). The cultivator, when employing this tool, adopts a kneeling attitude.

The Lugbara and Madi women do all the weeding of the crops grown by these people with the help of a small wooden elbow-hoe, *longudi* (*Lugwara*), which is not seen elsewhere in Uganda. It is carved from a natural crook often cut from the tree *Butyrospermum parkii* and consists of a curved spear-shaped blade made in one piece with a handle at an angle of forty-five degrees, the elbow being knobbed so that the whole is somewhat similar to a stork's neck, head and bill. Besides its use for weeding this tool is utilized for worrying out grass from a plot originally broken up by a man with an iron hoe. The *longudi* is held in one hand, the clods are broken by blows with the knobbed angle, and the grass and weeds are then raked out with the blade and collected with the free hand. The *longudi* is also used by the women for beating out the seed from dried bean plants. For the delicate work of removing small weeds from young millet and other broadcast crops a single shell of the freshwater mussel may be used by the Lango, Alur and Acholi women. The weeds are chopped out by a downward and inward stroke with the shell held in one hand and gathered into heaps with the other, a kneeling or squatting attitude being adopted by the operator.

Harvesting Tools

Pruning of plantains and the cutting of the bunches are done by the Bantu with the help of a long-handled knife, *ekisalizo* (Lutoro, Luganda, Lunyoro), *oluhabyo* (Lunyenkole), *orushabozo* (Kigezi). The blade is semi-circular and has a tubular base into which is fitted a straight shaft some four or more feet long.

It is the custom amongst the Bantu tribes to remove sweet potatoes as required from the mounds in which they are grown and not to harvest the whole crop at once. A sharpened piece of wood or iron some eighteen inches long is used for this purpose, *ensobyo* (Lunyoro), *lusobyo* (Luganda), *empindu* (Kigezi). The hoe is not used for lifting sweet potatoes until the crop is past maturity and it is desired to clear the plot.

For harvesting small and large millet, knives of great variety are used. Such of the Bantu tribes as grow millet make their harvesting

knives from any piece of thin, flat metal such as hoop iron, often wrapping cloth round one end for comfort in use, *engyesho* (Lunyankole), *emibyo* (Luganda), *omusyo* (Kigezi). Similar knives are used throughout the Bantu country by the women for domestic purposes, such as peeling plantains and potatoes. The Iteso also are not particular as to the design of their knife. This apparently was not always so, as Kitching (1912) recorded the use of a miniature sickle with a finger ring. The Lango and Acholi employ either a small-handled knife, *pala* (Acholi), or a small ring-knife, *alwete* (Acholi), which is fitted over the thumb. The ring is a tube of thin iron or brass some three-quarters of an inch in depth and has the upper edge sharpened. The first and second fingers are slipped up the stalk of millet until they reach the head, when the ring edge is pressed with the thumb against the stalk, severing it near the head. The Alur people have a knife with a short right-angled blade. The inner edge only of the upper arm is shapened and by pressing the millet head against the blade the stalk is severed. The Lugbara knife, *eli* (Lugwara), is of unique design, having an oveate double-edged blade fitted into a short ornamented handle. The Madi knife is similar to that of the Lugbara, but instead of the long blunt spike at the apex the blade is truncated, leaving a narrow cutting edge at the top in addition to the two lateral edges. These knives are essentially women's tools and are carried by them wherever they may go.

Special Implements

Coffee pruning knives and saws have for some time past been sold at cost price by the Agricultural Department to cultivators of both Arabica and Robusta coffee. The saw consists of a fifteen-inch curved blade with a short straight wooden handle and large teeth which do not clog when used upon green wood. The pruning knife has a curved blade of four or five inches and, being made of tempered steel, is a more durable article than any locally produced knife and therefore is in considerable demand.

Manufacture, Trade and Ceremonial Uses of Agricultural Implements

Smelting of local ironstone and the preparation of soft iron was at one time a thriving industry in Uganda and the products occupied an important place in the internal trade of the country. Concretions of iron oxide were the raw material preferred and certain localities became famous for their iron work. Kitching (1912) mentions Busindi and Mwenge as noted sources of hoes. The trade in hoes from Busindi, now Masindi in Bunyoro District, had wide ramifications. The Baganda and Basoga traded with the Bunyoro for hoes, as also did the nearby Nilotic peoples across the Nile. According to Driberg (1923) the Bunyoro hoes traded to the Lango for cattle demanded a high price, three hoes being considered equivalent to one heifer.

The environs of the Labwor hills on the borders of Acholi and Karamoja Districts, the North Madi hills and the Okebo country in the West Nile highlands are still noted amongst the Nilotic peoples for the excellence of their implements. A small trade in hoes still survives in the West Madi country, where the native iron workers exchange their manufactures for food with the Sudanese. For the marriage "dowry" trade hoes are not accepted by the Madi, and although now used only rarely for cultivation the native-produced hoe forms an essential item and is valued at about four shillings.

The introduction of hoes of European and Japanese manufacture, which are more durable than the native product, is rapidly stifling the trade of the native smith, who, except in a few inaccessible districts, is now only a part-time craftsman, such work as he does being the building up of worn-out hoes and the making of spears, knives, slashers and arrowheads from scrap iron. Increase in the prices of trade hoes as a result of the present war has given a small impetus to the native industry.

I wish to express my gratitude to those members of the Uganda Protectorate Agricultural Department, who supplied information.

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NOTES ON PLANT DISEASES

APPLE MILDEW

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The disease known as "Apple Mildew" is the cause of the stunted trusses of narrow curled leaves, covered with a white mealy powder, which are often seen when the trees come into leaf. Flower buds, as well as leaf buds, may be infected and produce clusters of small flowers with narrow petals which fail to set fruit. Infected leaf buds may be killed outright, but more usually the shoot develops, each leaf being covered with mildew as it unfolds so that the whole of the shoot presents a white powdery appearance. In some varieties the shoots lose all their leaves except a tuft at the apex.

These wholly infected shoots constitute the "primary" outbreak and are the result of dormant buds being infected the previous season, the fungus hibernating until development of the buds begins.

This powdery summer stage of the fungus consists of fine fungus threads which grow on the surface of the leaf. The fungus obtains nutriment by means of minute suckers which penetrate the epidermal cells. This is a characteristic of all the powdery mildews. In the actively growing summer stage they are essentially external parasites. The fungus threads forming the white mat send up into the air short branches each bearing a chain of oval spores which are produced in such quantities as to give the surface the characteristic powdery appearance. Spores produced on the "primary" infected shoots may spread to other parts of the tree and to neighbouring trees and so bring about "secondary" infection.

In addition to the powdery summer stage there is a winter or resting stage of the fungus. This consists of round spore cases (perithicia) containing small spore sacs (asci). In the spring these rupture and liberate the spores. The winter fructifications can be seen on the mildewed shoots as minute black dots embedded in the white weft of mycelium.

It is not known to what extent these winter fruit bodies occur in Kenya, or what part they play. In England they do occur but are very frequently sterile. The most usual method of over-wintering is by means of the hibernating mycelium in infected buds.

There is considerable difference in varietal susceptibility to the disease. Some of the most susceptible are Lane's Prince Albert, Bismark and Cox's Orange Pippin, King of Tompkin's County often suffers severely at the higher altitudes in this country. The general condition of the tree, type of soil, cultural practices and type of root stock all affect the incidence and severity of epidemics and outbreaks. Cox's Orange Pippin, for instance, worked on Malling I stock is very susceptible but is resistant on stocks Nos. XVI, IV and XV.

Control Measures

As the new outbreaks each season arise, in the main, from infected buds, the removal of these before they develop should prevent the establishment of the disease. In the dormant season infected shoots can be recognized by their pale grey colour. They should, if possible, be all pruned out before the tree comes into leaf. Any infected shoots and flower trusses which later appear when the tree comes into leaf should also be removed if practicable. These operations, if done systematically, should be sufficient to keep the disease in check. If, however, it is not possible to eliminate such sources of infection or, if the orchard is liable to be infected from neighbouring trees, spraying may be resorted to.

Apple mildew, like all other powdery mildews, can be checked by applications of sulphur either in powder or liquid form, as lime sulphur, colloidal or precipitated sulphur. Trials at East Malling show that lime-sulphur controls both mildew and scab when applied once before and twice after blossoming. The strength of the pre-blossom spray is 1:30, applied at about the "green bud" stage, i.e. when the buds are clustered in the rosette of leaves but before any pink is showing. The post-blossom spraying is done after petal fall and again later with the 1:100 strength lime sulphur.

Some varieties of apple tree are liable to damage when sprayed with lime-sulphur sprays after blossom set. For these, a post-blossom spray of soft soap and washing soda at a strength of 20 lb. of washing soda (or 8 lb. of Magadi soda) and 10 lb. of soft soap to

100 gallons of water can be used. Caution should be exercised with all these spray fluids until the reaction of trees under the varying conditions in Kenya is known.

In New Zealand, where the disease is troublesome, the following spray schedule is employed. A pre-blossom spray of lime-sulphur, 1 : 30 at between the open cluster and pink bud stage, followed by an application of precipitated sulphur at a strength of 10 lb. in 100 gallons of water. If the attack is severe a further application is made two or three weeks later.

More recently other combinations and sprays have been used with success. Lime-sulphur 1 : 200 plus colloidal sulphur (25 per cent sulphur content) at 2 lb. to 100 gallons has been found to be more effective than lime-sulphur (1 : 100) or colloidal sulphur used alone. The advantage of the sprays prepared with precipitated, wettable or flotation sulphur is that they are less liable to cause sulphur injury than is lime-sulphur. They are generally useful as post-blossom sprays, but do not replace lime-sulphur as a pre-blossom spray.

The action of sulphur is most effective during warm dry weather, which also favours the development of powdery mildews. These fungi, being external, are susceptible to the direct action of the sulphur particles. Copper sprays, the action of which is different from that of sulphur fungicides, are not effective against powdery mildews.

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APPLE MILDEW

Shoot showing "primary" infection of the apical bud.

RICE GROWING IN DRY AREAS

By R. B. Allnutt, B.Sc., Agricultural Officer, Tanganyika

The Sukuma grow rice where many other tribes would never dream of doing so. Their practices, though not unique, are unknown to thousands of cultivators who could easily adopt them.

In these days new sources of supply of rice are urgently required, and it is important that none be overlooked. In the past I have myself been blind to the rice potentialities of more than one area of Tanganyika, but the Sukuma have peeled the scales from my eyes. It is the possibility that I have not been the only sufferer from "rice blindness" that prompts me to offer this account of rice growing in the Shinyanga District of the Lake Province of Tanganyika, in the hope that it may assist others to assess the chances of successful rice culture in their part of the world.

A description of Sukuma agriculture, including rice growing, has recently been published [1]. I hope that readers who are familiar with it will forgive some inevitable repetition here, and will find sufficient new matter to repay their trouble.

Shinyanga is at present one of the least important of the rice growing areas of Sukumaland, but I have chosen to describe the methods used there for three reasons:—

(i) It is the part of Sukumaland that I know best.

(ii) It has perhaps the least favourable climate for rice of all Sukumaland, and so makes a better yard-stick than the less arid areas further north by which to measure the chances of other districts.

(iii) It is an example of a district where thousands of natives who had never before grown rice have quickly and successfully adopted the methods of their neighbours in adjacent districts.

The Milieu

Climate.—The rains are most erratic. Their onset may be sudden or may be heralded by an advance-guard of rather local showers spread over three or four weeks. The true or general rains may break any time between early November and early December. They end in late April or early May. The total fall over this five or six months generally ranges between 25 and 35 inches, but is often badly distributed. One or more rainless spells of two, three or even four weeks duration are to be expected. Mid-May to October is usually completely dry. The humidity of the air is low, extremely so in the dry season and in those long dry spells of the wet season.

Average temperatures mount from 22.5° C. in June to 25.75° C. in October. With the break of the rains the average temperature drops to about 24.5° C. in December and January and it continues to fall gradually throughout the wet weather to 24.0° C. in February and 23.5° C. in March, April and May.

Elevation.—The rice areas are situated about 3,500 to 4,500 feet above sea level.

Soils.—Light sands, sandy clay loams, heavy clays, hardpans and alluvium are all used for rice cultivation. Light soils are only used in places where a continuous supply of water is available.

Natural Vegetation.—Most of the land has long since lost its original natural flora. It has become "cultivation steppe", that is, land which has been heavily cultivated and grazed for many years. When it has been out of cultivation but under grazing for some years the land generally carries a growth of short grass with a few scattered shrubs. In the less densely settled areas and in tsetse fly country there may be fairly close stands of light bush composed mainly of species of *Acacia, Combretum, Anisote, Commiphora, Bauhinia, Terminalia* and *Cassia.* But as a general rule it can be said that bush clearing for rice cultivation is only a light job.

Topography.—The country is rolling. Long gentle slopes drained by small, seasonal spruits are the general rule. Permanent running water is practically non-existent, though water can be obtained by digging in the sandy beds of countless small streams and a few big ones. The landscape is dotted sparsely with fairly steep hills surmounted by granite kopjes. There are many low, rounded hogsbacks devoid of boulders, but often characterized by low outcrops of granite or ironstone. These uplands fall away gently to almost flat valleys of varying dimensions—some of them are many thousands of acres in extent. On the upper slopes of the hills the light soils are found, on the lower slopes the clay loams and hardpans, and the valleys provide clays and alluvium. Seepage is forced to the surface where the light soils closely overlie the less permeable clays and hardpans.

The Cultivator.—The Sukuma are generally conceded to be one of the most industrious of Tanganyika tribes, and a people who are very responsive to a lead from their chiefs. Men,

women and children all work in the fields. They are accustomed to use a long handled hoe with a 2½–3½ lb. blade. In tilling the land for their staple crops they are used to either ridging the soil or else hoeing it to a depth of three or four inches, as opposed to the mere scraping of the surface which passes for cultivation with many tribes.

The Status of Rice.—To most men rice is a subsidiary crop. The staple foods are sorghum, bulrush millet, maize, groundnuts, pulses, sweet potatoes and cassava. Rice is used as a food to an appreciable extent, but is chiefly grown for cash. In some areas it has become the main cash crop, but in most it takes second place to groundnuts or cotton. There are a few old hands who specialize in rice both for food and cash, and plant as much as two acres of it, but the ordinary man does not grow more than about a quarter of an acre at present. Next year we expect the average will be at least half an acre. Now, ten years ago a rice grower in Shinyanga was almost a curiosity; about five years ago rice growing began to receive some official encouragement; only in the last two years has the Government taken a very active hand in pushing the crop. It is during those two years that the status of rice has risen from insignificance to importance in native economy.

The Method

The Site.—Many tribes think it is impossible to grow rice except in swamps or inundation areas. They are wrong. The Sukuma do use natural swamps for rice growing, but only to a limited extent. For the most part they create their own swamps. How? Either by impounding seepage or by impounding surface run-off. The site they choose is either just below a seepage point or else it is at a place which receives naturally, or to which they can lead artificially, the surface run-off from a catchment area above. When seepage water is available the type of soil is not important; light soils will do because the water supply is more or less continuous. When run-off is the sole water supply it is essential that the soil should be heavyish and retentive, because, as has been mentioned, long dry spells are not uncommon, and a single fall of rain may have to keep the crop going for three or four weeks.

Impounding Water.—Water, whether from seepage or from run-off, is impounded in what some people call dams and others call terraces. Probably box-terrace is the best description. They are made by casting up banks both across the slope and up and down the slope, to form a series of inter-communicating, shallow, lidless boxes with earthen walls. The floor of the box is sloping in the first instance, but is often levelled off later so that a true terrace is formed, a terrace with an earthen bund around it. The dimensions of terraces vary a great deal. The steeper the slope the smaller the terrace. On slight slopes the banks can be 25 yards or more apart; on steep slopes they may be only five yards apart. The height of the banks also affects the size of the terraces. The higher the banks are the wider apart they can be. They may be anything from one to four feet in height, but a height and width of eighteen inches is usually sufficient. The main desideratum is that when your earthen box is flooded the whole floor of it shall be well covered with water; if the floor slopes much the lower bank must be big, if it is level the bank need only be about one foot high. Twelve inches of water will carry the crop over a long dry spell if the soil is really retentive.

The Banks.—These are made with an ordinary native hoe. The bigger the hoe blade the better, within reason, because a good sized sod can be cut, lifted on the blade and deposited on the bank in one almost uninterrupted action. If only a small hoe is available the earth has to be scraped up laboriously. If the soil is either very sticky or rather dry many men prefer to dig a strip of land and then collect the clods by hand, or on a small wooden tray, and thus transfer them to the bank. The bunds needs to be consolidated, so it is preferable to make them when the soil is thoroughly moist and can be properly tamped down.

Levelling.—Terraces are generally levelled gradually over a number of seasons. On heavy soils levelling can only be done when the land is wet, but it is not quite so laborious as one might expect. The cultivator works with his back to the low spot; down comes the hoe, then a forward push on the handle levers up a big clod on to the hoe blade and a backward lift and swing chucks it yards behind him. Levelling, though often desirable, is by no means universally essential; common sense will indicate whether it is really necessary or not, in a particular instance, to ensure the proper flooding of the whole terrace.

Water Control.—Water, either from seepage or from run-off, banks up against the topmost bund of the series of terraces and is conducted into the terraces through one or more gaps in the bund. If the topmost bund does not trap enough water it is necessary to throw up a training bank, aligned to tap the discharge

from an an adjacent area and lead it to the terraces. When seepage provides the water supply a storage pond is sometimes dug just above the terraces to conserve water for irrigation during dry spells. Many such ponds already exist. They were originally dug for watering cattle. Now they often serve a dual purpose. One occasionally sees a combination of both pond and training bank.

The passage of water from the upper terraces to the lower ones is sometimes deliberately controlled by means of small cuts or tunnels in the intervening bunds, but more often the water is merely allowed to spill over the tops of the banks. If the banks are firm and well made there is no objection to this, but it is risky on light soils, especially if big discharges of water may be expected.

Grouping of many men's fields in one continuous stretch contributes greatly to efficiency. Any leakage through one man's banks finds its way to his neighbour's field, and so on from the top of the slope to the bottom. Furthermore the total running length of bank required is greatly reduced.

The excavation of ponds, construction of training banks, building of bunds and levelling of terraces can be done at any time of the year when the land is soft enough, generally from December until April or early May. These works are of a capital nature, and once finished they last many years if kept in repair.

Preliminary Cultivation.—Having embanked the plot, the next step is to get the land into condition for planting. This is done in two stages. First the land is deeply hoed when it is moist enough for thorough digging. In hoeing, the sods are completely inverted so that the grass and weeds may be killed. The field may be left in this state for an indefinite period, sometimes only for a day or two, sometimes right through the dry season. But when the owner is ready to begin planting the field is flooded at the first opportunity. The water is left on for an uncertain period, but usually at least long enough to rot down most of the plant residues remaining after the hoeing.

Puddling.—When rotting is well advanced most of the water is run off and a second cultivation is given while the land is still wet. Any surviving weeds are removed and the clods of the first cultivation are broken down with the hoe or by trampling. Both this work and that of preliminary cultivation may be combined with some levelling in the manner described above.

Transplanting.—The puddling operation is followed immediately by transplanting. The seedlings are thrust singly into the muddy soil, usually with the fingers, but in very stiff land a dibbling stick is used. The spacing varies considerably, but the best results are obtained when the plants are put in about six inches apart. Young, vigorously growing seedlings are to be preferred, but people do use plants anything from six to twenty-four inches in height. Very tall seedlings are generally trimmed back to twelve or fifteen inches. Transplanting can be done from early December to early March in average seasons.

Nurseries.—The better cultivators sow selected seed in nurseries to provide themselves with plants, but many men rely on self-sown seedlings from the previous year's crop. The latter practice has obvious drawbacks and is not to be recommended. Nurseries are made at the very beginning of the rains, or even before the rains begin if a man has access to a permanently damp piece of ground at a seepage point or near a dam. The early preparation of nurseries is advantageous, but not always possible. It takes some six weeks for the seedlings to attain a suitable size for transplanting, so that if sowing is delayed until the main rains have arrived, six weeks of transplanting weather are lost and the long and tedious task of setting out the seedlings has to be crammed into a period of about six weeks instead of being spread over ten or twelve weeks as can be done if seedlings are ready early in December. Moreover the earlier plantings are generally considered to outyield the later ones. So it is important to utilize any early showers for starting off the first batch of seedlings. The nursery may be sown in one of the terraces of the main rice field or it may be located at some special place such as a dam, river bank or seepage point. The preparation is simple; the land is cleaned by hoeing and the seed is broadcast and scuffled in. Two or more nurseries may be sown at intervals of three weeks or so to provide a succession of planting material.

Broadcasting.—Although transplanting is usual it is not universal. Some people broadcast seed in all their terraces. They may do this before hoeing the land, so that the seed is covered during the act of hoeing. Others hoe once, then broadcast and scuffle in the seed with a second light cultivation. Broadcasting has its uses where the water supply is doubtful, or when the season is a droughty one, because a broadcast crop may survive a dry spell which is severe enough to kill seedlings transplanted just before the dry spell begins. It has the disadvantages that subsequent weeding and

thinning are much more arduous, and that in normal circumstances yields are lower. Generally speaking it is a lazy man's method and not to be encouraged except under the marginal conditions indicated above.

Weeding.—Most of the weeding is done by hand pulling, but a small hoe may be used if the land is not too wet. The amount of weed growth which has to be contended with varies a good deal with the type of soil and with the care given to the preliminary cultivation of the land. The lighter soils tend to produce the most persistent weed growth.

Harvesting.—The crop begins to ripen about three to four months after planting and harvesting extends over the months of March, April, May and June. The ears are cut singly as they become ready. Close spacing, by greatly reducing the number of late side-tillers, is a great help towards bringing the bulk of the crop to maturity at one and the same time, and so lightening the task of harvesting.

Ratooning.—Under exceptionally favourable circumstances of fertility and water supply it is sometimes possible to obtain a small ratoon crop from early plantings. After the first crop has been gathered the stools are cut back to about nine or twelve inches and a fresh flush of tillers may be successfully matured.

Varieties.—There are many different varieties grown. A description of them is beyond the scope of this article. It will suffice to name a few of the more important ones such as Afaa (or Faya), Sena, Majimaji, Bungala, Moshi, and Kanuke. The more enlightened growers plant pure stands of individual varieties, but these people are a minority. Indeed it is one of the chief defects of Shinyanga rice growing that the majority of men plant a mixed batch of seedlings raised from whatever seed they happen to have on hand or can acquire from their friends, irrespective of quality or yielding capacity. A brief description of some of the commonest varieties will be found in the publication mentioned in paragraph three [1].

Discussion

Dual Purpose.—Although the majority of Shinyanga men began to grow rice as a cash crop pure and simple, it has come to be recognized as a very useful secondary food crop. It used to be considered rather swank for a Sukuma of these parts to eat rice; now it is a commonplace. There is no reason to suppose that the same should not happen elsewhere. A district which takes up rice purely as a war time measure may be left with a useful legacy in the form of a new subsidiary food crop, even if rice growing for export should become uneconomic after the war.

Distribution of Labour.—A very important question that has to be answered when proposing to introduce a new crop or greatly to extend an existing one is: "How will it fit in with the normal farming calendar? Will it compete seriously with other crops for the peasants' labour?" So far as Shinyanga is concerned the answer is favourable in the case of rice, and I believe that it will be so in many other areas with a somewhat similar distribution of rainfall.

The greatest demands on the cultivators' energy are made during the first two months of the rains, when the staple grains and pulses must be planted and kept clean. Now the two biggest jobs in rice growing are the construction of terraces and the transplanting of the seedlings. Neither need compete seriously for labour. Terraces can be made when work is slack at the tail end of the rains, for use in the following season. Many thousands have been so made this year. Transplanting can be spread over the second, third and part of the fourth month of the rains and so can readily be fitted in with other jobs. It is especially easy when water supply is good. When it is either too dry to plant other crops or too wet to weed them, you can still transplant rice. What is true of transplanting is equally true of the preliminary cultivations and puddling.

In this matter of labour distribution rice is infinitely more adaptable than, for instance, cotton, which for the best results demands most attention during the first five or six weeks of the rains. In fact it is probably true to say that rice allows a more flexible distribution of labour than any other native crop in the district, except cassava.

Land Utilization.—In densely settled areas the introduction of one crop may oust another one because there is not enough land for both. In Shinyanga rice does compete for land to some extent with sorghum, sweet potatoes and pasturage, but not seriously. This is, however, a point which has to be watched.

On the other hand rice may permit exploitation of land which is of little use for any other crop. There is one soil type in Shinyanga, a sullen, intractable hardpan, which for all ordinary purposes is shunned by the cultivator; but it grows fine rice. Its impermeability allows it to hold water on the land longer than any of the other soils in the district.

Witchweed Control.—*Striga hermonthica* is a very serious pest of sorghum, the staple grain crop of the district. Now there are fields which

used to be so badly infested with *Striga* that it was almost useless to plant sorghum in them, but these same fields grow very good crops of rice. Stray plants of *S. hermonthica* are sometimes seen in rice fields, especially in dry ones, but there is no sign of its becoming a serious pest of rice. There is no evidence yet that the *Striga* seed in the soil has been destroyed, though it may well be that it would succumb to prolonged and repeated water logging. If it does, we have here a possible solution of the witchweed problem on soils which will carry both sorghum and rice. The two crops could be rotated. Even if the *Striga* seed should prove to remain viable for long periods in rice terraces the hard-pressed cultivator can at least rely on the rice in place of sorghum to supply part of his food requirements.

Soil Conservation.—Rice terraces give almost compete protection from erosion. And furthermore even land which has already been quite badly damaged by sheet erosion and incipient gullying has been found to support good rice crops when terraced. How it manages to do so is rather puzzling, but I have seen the most unpromising, bare, runnelled, sun-baked iron-hard wastes converted into flourishing rice fields. Probably the explanation lies largely in the mixed bag of silt, cattle droppings and small particles of plant refuse dumped on the terraces by water which has just scavenged the catchment area above.

Possible Difficulties.—In attempting to introduce the methods described to new areas, probably the chief difficulty in some places will be to overcome the prejudices of natives who customarily use a short-handled hoe with a light, small blade. It is true that it is quite possible to dig with such hoes, but it is a harder job, particularly in stiff land, and one that may quickly discourage the novice rice grower, especially if he comes of a tribe who normally merely scrape the surface and who gape in consternation if one suggests that they should dig. Even where the people possess long-handled heavy hoes there may be some distaste for certain jobs that have to be done. For instance it is a messy business hoeing a half-flooded rice terrace. Every hoe stroke sprays muddy water over the hoer. The old hand takes this as a matter of course, but it is easy to imagine it putting off the uninitiated. These may seem small points and though they ought not to be insurmountable, it is well to be prepared for them.

Another very important point is that even in places where the new hand has had perfect examples of rice terraces at his back doorstep for some years he is still prone to make his own bunds too far apart and too small when he first begins growing rice himself. This tendency is likely to be even more pronounced in a place where the method is entirely unknown, where tribal authorities are less influential and where the cultivators are less industrious. For this reason it will probably be wise not to expect strangers to grow more than about one-quarter of an acre in their first season, and to concentrate on getting them to make really efficient banks and terraces. This caution is specially applicable where terrace construction cannot be undertaken during the tail end of the rain previous to those in which the first crop is to be planted. If heavy bush clearing is necessary even a quarter of an acre may be too much.

It cannot be too strongly emphasized that slipshod bunding is bound to lead to failure, unless the water supply is exceptionally good. It is particularly necessary to have high, solid bunds on steep slopes and also in fields which

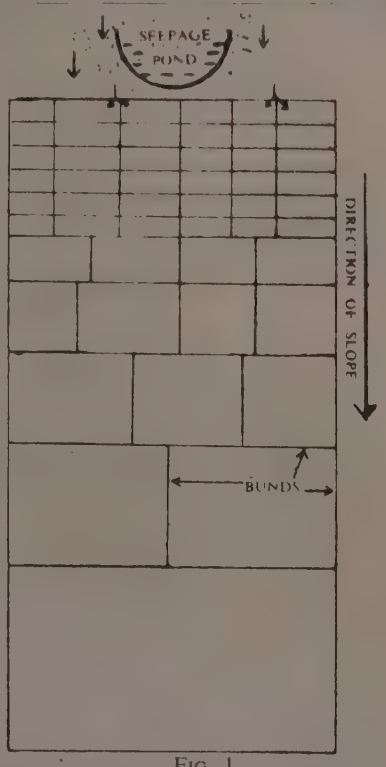

FIG. 1
Diagram of seepage-fed box terraces
Scale: 1 cm. = 10 yards

depend on a small catchment area for water supply.

Ideally the bunds which run across the slope should be dead on contour. But few natives have much natural ability at delineating a contour by eye, and unless a considerable amount of guidance is given it will probably be found that the efficiency of their bunding will be much reduced by this failing, particularly on the steeper and more broken slopes. Wherever it is practicable it is helpful to mark out contours for them. A striding level, which has been described in this journal [2], is a very suitable instrument for the purpose. It is not essential that the contour be followed precisely. Small deviations do not matter at all. But gross errors entail much extra work on heightening bunds and on levelling, if full and even flooding is to be achieved.

SUMMARY

A description is given of rice cultivation in the Shinyanga district of Tanganyika, together with such details of local conditions as are thought may be useful to the reader who wishes to consider the possibility of exploiting Shinyanga methods elsewhere.

Rice is grown on an erratic rainfall of about 30 inches distributed, often very badly, over a period of five or six months.

This is achieved by impounding seepage water and surface run-off in box terraces.

Rice is discussed briefly in relation to its bearing on food supply, distribution of labour, land utilization, witchweed control and soil conservation.

Mention is made of some of the difficulties which may be encountered in trying to introduce to other areas the methods used in Shinyanga.

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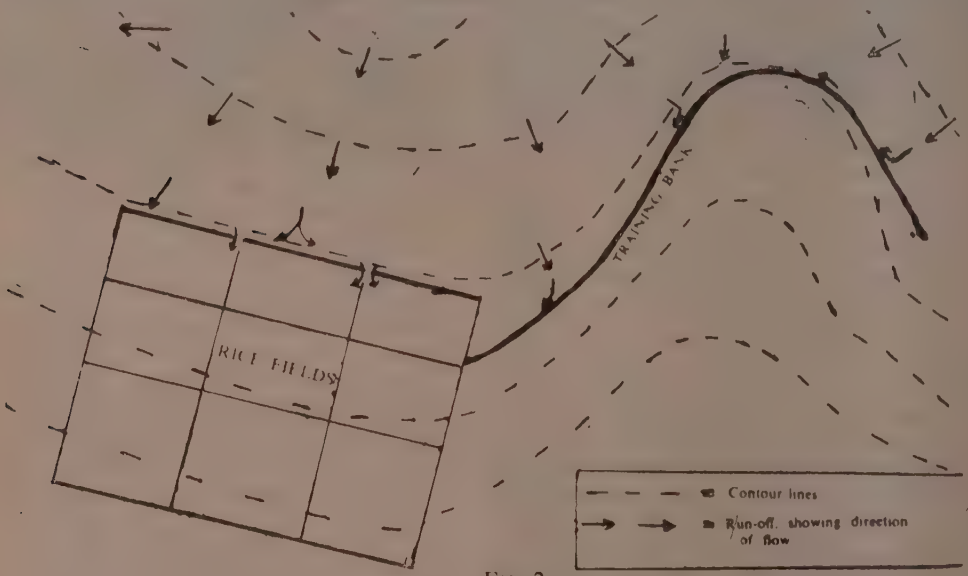

FIG. 2

Vertical section through long axis of Figure 1. Note increased size of terrace as slope of hill diminishes

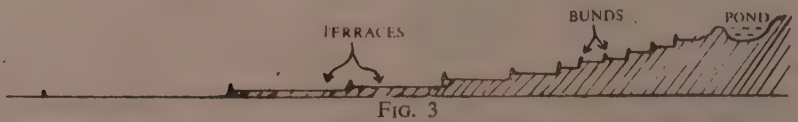

FIG. 3

Diagram illustrating the use of a training bank to augment the water supply

STALL-FEEDING OF GOATS AND SHEEP BY THE KIKUYU TRIBE, KENYA

By W. Lyne Watt, M.B.E., Senior Agricultural Officer, Kenya

It would be difficult for anyone to travel a short distance in the Kikuyu country and not see women carrying heavy head-loads of sweet potato vines. These are being brought home from the cultivated fields for feeding to the stall-fed animals, which are kept in almost every family village.

The three districts of the Kikuyu country cover some 1,315 square miles, and stretch over steeply undulating ridges from 4,000 ft. to over 8,000 ft. elevation. The population is some 448,840, which gives an average density of about 341 per square mile.

Although the maize, millets and pulse crops are very valuable at the present day, the sweet potato crop still plays a much more important part in the life of the tribe in supplying a daily ration of roots for the family pot, and a steady supply of fodder for stall-feeding.

Until recent years, the Akikuyu grew and collected the seeds of castor oil throughout the length and breadth of their land, and one could always see capsules laid out on hides to dry in the sun. These were crushed and the oil used for smearing on the pig-tailed hair and bodies of the warriors, and to a certain extent in the preparation of skins for clothing. Apart from this, no vegetable oils were grown and used by the Akikuyu. In consequence, over a period of many generations a system of stall-feeding of animals was evolved, which gave the much-needed supply of fat necessary for food and toilet.

Any male goat or sheep is used for this purpose and stores are bred locally or bought in from neighbouring tribes. Large flocks of billy goats and rams come in daily from the Northern Frontier Province and move through Kikuyu from market to market, being quickly bought up by the tribesmen. The greater number are either slaughtered immediately by their purchasers, or, more commonly, are stall-fed for at least a number of months till they are in suitable condition for slaughter, or till they are required for some ceremonial purposes. The goats and sheep being herded on the hillside are the breeding stock, the main purpose of which is to produce males for stall-feeding.

Stall-feeding may commence at any age, but with home-bred animals it is generally just after weaning. This enclosed feeding continues sometimes for as long as two years, depending largely on the wealth or needs of the family. Any flesh which cannot be eaten by the family is given away free to neighbours, who in turn reciprocate when they slaughter their own sheep or goats.

The billy-goat (*thenge*) has to be castrated after six months and before feeding commences, but the rams (*ndurume*) are seldom done. The method of castration varies with the skill or belief of the individual owner. Some bite the cords with the teeth, which has much the same effect as the burdizzo instrument of the modern stock-man. Others place the testicle on a log of wood and hammer it with a club, while others remove the vital parts by cutting. It is not uncommon with some owners to sever the cords by the repeated use of a pricker made by the local blacksmith.

When stall space is available, many keep some of their ewes indoors, believing that it ensures a higher proportion of twins at lambing.

In recent years pigs have been kept by a few of the more progressive tribesmen for their earlier and greater supply of lard. There has been keen competition between keepers for the record return of lard from any one animal, and quantities of over six four-gallon tins are sometimes procured.

Thenge goats and *ndurume* rams (*ngoima*) are kept in stalls (*gichegu*) which are generally built up to the perimeter of the round mud-walled huts. Wealthy people have special huts built for the purpose, while the poorer families, who are only able to keep one or two feeders, will erect the stall in their living hut. It is built of round timber, usually 6 ft. by 5 ft., and has a raised wooden floor about a foot above the level of the earth floor of the hut. All food is hung up by means of a string from the top of the stall wall. In this way the fodder is kept free from any contaminating influence, and stall-fed animals rarely if ever suffer from intestinal worms. Animals reared in these dark huts rarely leave them till they are either sold to someone, taken to pay some fine, or slaughtered for family food. One can occasionally see a fat ram being pushed along a path by its owner, having long since lost sufficient energy for walking.

Banana Skins for Stall Feeding

Potato Vines for Stall Feeding

A *Ndurume* Ram

A *Thenge* Goat

A Stall-fed *Ndurume* Ram

A Stall-fed *Thenge* Goat

No bedding is used in the pens, otherwise the stores might eat it. The raised floor is swept out daily and the manure thrown on a heap beside the gate of the village. All urine drops through to drainage channels below the pen, and passes through a hole in the hut wall and on to the grass or bush nearby. In recent years, practically all the manure is used in the compost pits, or applied direct to the fields from time to time. Few now advertise their wealth in live stock by creating a large pile of manure within the village compound.

Food is almost exclusively sweet potato vines (*mirio*), but during periods of shortage, sufficient vines of certain creeping plants can generally be found in forest areas, or by the rivers and streams. In recent years, some of the more progressive and enterprising people are using maize thinnings, Napier grass and other crop stover to augment the potato vines.

It is seldom necessary to give water when the animals are on a full ration of potato vines, but occasionally when salt and soda has been added to the water for cooking the family vegetables it is poured off and given to the stall-fed goats and sheep. At intervals of a few days salt-lick (*munyu*) is stirred thoroughly in water and given.

Any of the many sweet potato varieties can be used, though some are preferred for their higher yielding or drought-resisting qualities. The kiringa is more of a perennial type than the others and scarcely produces any tubers, but carries a good leafage throughout the dry periods. Kiganda is a recent introduction, and already forms at least 50 per cent of all sweet potatoes in the Central Province. It is the highest yielder of vines and tubers, though the latter are rather poor keepers. Other popular varieties for stall-feeding purposes are moundwe, mukunungu and nduhia.

There are two main fats obtained from the stall-fed goats and sheep, the more valuable internal fat (*ngurunyu*) used for roasting meat and bananas, or mixed in soup and gruel, whilst the skin and tail fat (*riuwa*) was generally used for external application, until in more recent years the cheaper simsim and coconut oils could be imported from elsewhere and used instead. This *riuwa* fat was also used in the preparation of skins when worn by the tribe. These two fats are rendered down and stored separately in clean dust- and rat-proof tins and jars till required. The rendering down of the fats is done in the usual way by adding some water and boiling till the water has evaporated. It is then strained through dead bracken leaves in preference to grass.

A well-fed *thenge* goat will give up to two gallons of fat, and the *ndurume* ram slightly higher. When sold in peace time a good goat was worth Sh. 40 and a finished ram Sh. 30 to 40. The present price of a goat is about Sh. 60.

These stall-fed animals are of such importance in the life of the tribe that it has been necessary for Administration in each of the three districts to fix their average value for assessing court fines. Every dowry paid in the Kikuyu country must embrace at least one *thenge* goat and two *ndurume* rams.

The fat of the goat is considered the better by the Kikuyu people, and the skin fat is generally used for food too. A sick man must eat goat flesh and soup made from it, other meat or flesh being considered lacking in strength-giving qualities.

If one should meet a person in the Kikuyu country with an oily skin, the customary salutation to use is: "I see you have been visiting your grandmother". It is the tribal custom to anoint the skin with oil at regular intervals throughout life, but when a child visits its grandmother it is rubbed over with oil daily, once or oftener, from her own supply of fat or oil. While it is the custom to oil the skins of girls throughout life, the oiling ceases with boys when they reach 12 years of age, to be resumed again after circumcision, which is about the sixteenth year.

METHODS OF FEEDING LABOUR

While methods of feeding labour continue to vary considerably, greater attention is being paid by an ever-increasing number of employers to this most important subject. On some estates well-balanced diets have continued to be issued and on others new scales of an improved dietary have recently been introduced. On one estate daily tasks were increased by approximately 20 per cent without trouble and with no hardship to the workers as the direct result of the introduction of a well-balanced and health-giving ration. This is mentioned as a matter of interest and in support of the argument, not generally accepted by employers, that generous expenditure on good food and good living conditions is sound economy.

Annual Report of the Tanganyika Territory Labour Department, 1941

REVIEWS

Agricultural Marketing in the Colonial Empire.

In the *Empire Journal of Experimental Agriculture* for January, 1942, there appears an account of the more important features of agricultural marketing in the Colonial Empire, by Dr. H. A. Tempany, Agricultural Adviser to the Secretary of State for the Colonies. The article is based upon information collected in 1940 through Directors of Agriculture and Veterinary Services.

The first observation made is that there has been marked progress in the organization of agricultural marketing in the Colonies of recent years, but that efforts have been concentrated mainly on commodities for export and local marketing has been relatively neglected. It is precisely in relation to export commodities that the "bull-at-a-gate" methods of wartime control have had to be applied. Pre-war development is in consequence somewhat overshadowed and the article under review may seem at the moment to be mainly of historical interest. However, much of the preliminary work is built into the new wartime structure. When there is time to look around there will have to be a stock-taking. We shall have to examine where the edifice has diverged from the pre-war plan. Probably some of the new building will be seen to be good; undoubtedly some will deserve demolition. In making judgments the usefulness of an evaluation of the pre-war position needs no emphasis. It is only to be hoped that the factual material for post-war evaluation will be to hand.

The marketing process falls into two broad divisions, in which the mechanism bears a different character. On the one hand we have the case where a multitude of small producers, mostly illiterate and ignorant of the broad principles of commerce, bring their produce to market in driblets. On the other hand we have plantation owners and members of more advanced communities who are either on a big enough scale to market their produce independently or are able to combine on their own initiative for the attainment of a recognized object.

In regard to the latter division there is a clear trend away from the system of individual sale to private commercial agencies, in the direction of centralized selling on a pool basis by co-operative associations or statutory boards. "Compulsory co-operation" has been applied to wheat, pyrethrum and passion-fruit juice in Kenya, maize in Northern Rhodesia, coco-nut products in Jamaica, arrowroot in St. Vincent. In addition, there are a number of voluntary associations such as the Kenya Farmers' Association, the Kenya Co-operative Creameries, the Coco-nut Growers' Association of Trinidad, etc. The objects of these associations are to pool the produce of individuals and sell in bulk, thus eliminating competition between the individual producers and securing recognition for the produce in the market, to standardize quality and packing, to reduce marketing costs and to assist in securing finance. The object of introducing compulsion has been twofold: firstly, to prevent the undermining of prices by independent selling, and secondly, to safeguard the reputation of the product. The second object is perhaps based on doubtful premises. It rests upon the alternative assumptions that the mark of an association is incapable of protecting the reputation of its produce against that of other produce from the same region, or that producers cannot be relied upon to adhere to an association which is returning dividends by safeguarding the reputation of their produce.

The marketing of the produce of small illiterate producers is no doubt the larger problem in the Colonial Empire. The basic system is sale to the local shopkeeper or itinerant trader. This is a two-way traffic: the same organization which serves for collection of the small parcels of produce serves also for the retail sale of trade goods. Overheads are thus spread and the system is enabled to extend into remote and sparsely populated areas. It entails the disadvantage that the small trader knows little about the commodity he is buying. All qualities are alike to him. He makes no differentiation in the price between poor and good qualities, between pure and impure samples, and the grower has no incentive to improve quality.

With the object of remedying this drawback, systems of pre-sale inspection have been instituted, particularly in East and West Africa. Official inspectors examine the produce as it is being brought in to the selling centres, and all produce not reaching the requisite standard is rejected. Facilities for sorting over the produce are sometimes provided. For instance, in Kenya simple winnowers have been set up for maize.

Inspection must be applied at the point of first sale, as only thus can the grower be educated. This does not prevent subsequent mixing

by the local trader, short weight, and the use of inferior bags, so that trade by telegraph between local trading centres and the main wholesaling and exporting centres is still subject to risk. To be complete, the inspection system would have to include inspection at a railway warehouse. Official inspection or grading at the port is usually maintained in regard to both peasant and plantation produce of certain kinds. An endeavour is sometimes made to prevent unsound trade practices on the part of traders by a system of licensing. Generally speaking, the field between grower and exporter is inadequately covered by regulation measures.

In order to facilitate inspection, sale is confined to specified markets. A development of recent years in Kenya deserves mention. Formerly, produce was sold to Asian traders in trading centres situated outside the native reserves, generally near a railway station. Part of it was collected in the native reserves by native traders and transport owners who were none too scrupulous or enlightened in their methods. Of recent years native trading centres have been established within the native reserves, at which the same kind of control is exercised as in the outside centres. In this way the native trader has been anchored and his operations brought under supervision.

Inspection of weights and measures is provided for by legislation in almost all territories. It is not carried out intensively enough, however, to exert much influence in practice. The chief danger is not so much the use of inaccurate machines as manipulation in the process of weighing and false calculation. Whether the danger is as real as is popularly supposed is a matter for conjecture. Instances have been observed, but "one swallow does not make a summer." According to one view, the native peasant, in some tribes at least, does not bother about the weight but takes his little load from one trader to another until he has made the best bargain possible. Obviously, in following this course, he depends on the existence of real competition between the traders, and when it is absent he is in a bad case. In few places is independent weighing provided for, as in the "regulated markets" established in certain parts of India. Because of the difficulty of maintaining adequate inspection, and the ease with which an illiterate peasant may be imposed upon when an avoirdupois scale is used, Kenya has made compulsory the use of specified volumetric measures for certain classes of produce, and similar powers have been taken in Tanganyika.

The problem of market control in East Africa is somewhat complicated by the fact that the local produce markets are unlike those in, for example, the United Kingdom and India. They are better described as shopping centres than markets. Selling is more or less continuous and desultory. Contrast them with the weekly market days in Indian villages and small towns, where large amounts of produce are concentrated and sold within the space of a few hours. These markets are attended not only by local traders but also by representatives of the big wholesale firms and exporters. The volume of trade justifies this. At the same time, it becomes possible to concentrate efforts at market regulation, to provide an inspection service, post up prices ruling in the central markets, export parities, etc., and to provide for official weighing. The large wholesalers and exporters can by-pass the local trader and avoid the risks of dealing through a third person. Competition is concentrated. The influence of purely local factors affecting supply and demand is minimized. Economies in reloading and transport are often possible. The system typical of East Africa may be partly due to the fact that native cultivators do not generally own bullock carts, and bring their produce to market in small lots within a narrow radius. The result is that there are no large concentrations of produce worthy of the attention of distant wholesalers. It is partly due, also, to the fact that the local trader, selling his piece-goods, sugar, hurricane lamps, and jack-knives has attracted the produce trade to his shop instead of going out to a produce market to buy. He argues that the latter practice would simply increase his overheads. It is a case of the chicken and the egg—difficult to tell which is cause and which effect. It seems rather a pity that more has not been made of the periodical native markets which exist nowadays largely for the exchange of snuff, beads, local produce and gossip. Though these markets serve a useful purpose in local exchange and conduce to a more varied diet, they have been by-passed by the trade with the outside world and give the impression of mere interesting survivals for the sightseer.

From the local trading centres the produce passes through a varying number of hands before it reaches the exporter or consumer. Each of these carries on his business with a margin of profit. The popular conception is that each middleman takes his toll before passing the produce on to the next buyer, and that therefore the more middlemen there are the greater is the spread between the price received by the

producer and that paid by the final buyer. This is putting the cart before the horse. It is as much as to say that if one engages relays of porters to carry one's bag to the train it is because there are too many porters in attendance. There may be instances in which entrenched interests prevent short cuts, though in general such interests are more characteristic of terminal markets and of the trade in branded manufactured goods. There is no evidence that it applies in any degree to primary produce. The middleman cannot exact a margin. He is allowed it because he performs a service for which somebody is willing to pay. It may be because he bulks the produce into larger lots, or maintains a stock so that he is able to fulfil an order at short notice, or furnishes the necessary credit and office work, or buys produce speculatively and takes the risk of price fluctuations, or merely maintains a reputation for general reliability. Nobody would willingly buy at a dearer price if he could obtain the same produce of the same quality, combined with the same services, at a cheaper rate. The existence of a chain of middlemen points to the need for particular services. The fact that these services are performed by separate individuals or classes may be merely an instance of specialization of function, and it does not follow that the service is necessarily more expensive simply because it is split up among several contributors. The trend of economic organization was for a long time in the direction of greater specialization. If a later trend has been towards integration this may be due to the greater aggressive power so obtained rather than to actual savings. The specialization may still be there, in fact, but between individual employees of the same firm. It would be difficult to show that the large integrated businesses of modern times have reduced the spread between prices of primary produce to the producers and the prices paid by consumers, though they have undoubtedly introduced improvements in processing and packing. One of the reasons given for occasional failures of attempts at co-operative marketing is that the promoters failed to realize that they could not cut out the middleman's services even if they succeeded in cutting out the middleman; they had to justify their existence by rendering the same service more economically. In short, if there is too wide a marketing margin, it will not be reduced by merely cutting down the number of people engaged, but only by improving the mechanism of the process.

The promulgation of minimum prices to the growers based on current world market prices is confined mainly to those cases in which competition has been restricted by official intervention. The prices displayed at market centres for produce bought in competition are usually those which the traders are offering for the day. Centres cannot be inspected every day, nor are district agricultural and administrative officers in constant touch with variations in world prices and their local equivalents. Hence the posting of prices can have little effect beyond creating greater uniformity and preventing victimization of individual sellers.

The article under review is rather a conspectus of the measures adopted to improve marketing systems in the Colonies than a critical examination of conceptions and results. Only passing mention is made of one of the most important departures, albeit one peculiar to East Africa, namely the granting of exclusive licences to individual trading firms and groups of firms purchasing native produce. It aims at extinguishing competition among buyers, and at replacing the competitive element as a safeguard to producers by official fixation of minimum prices. I have offered some observations on this system in an article published in an earlier issue of the *Empire Journal of Experimental Agriculture* (VIII, 32, October, 1940).

It is somewhat difficult to reconcile on the one hand, in more advanced communities, the adoption of producers' associations, having as their object the strengthening of their hands against wholesale buyers, with, on the other, the establishment of buyers' associations or monopolies dealing with unorganized illiterate producers. Obviously in the latter case everything depends on the measures taken to ensure that the minimum prices fixed are as high as the actual prices would have been under competitive conditions. It can hardly be claimed that these measures are yet adequate, and it is not surprising that where the system has been applied, trade margins have tended to widen or compare unfavourably with margins in competitive areas. Committees composed of interested buyers, a member of an agricultural department with a scientific background, and an administrative officer, do not constitute a balanced authority. Little has been done in the way of economic investigation to strengthen the hands of the official members on whom the interests of the growers depend. In the reaction from *laisser faire* there has been a strong tendency for economic control to pass to "vested interests". This was noticeable in the later "twenties" and some would attribute the severity of the 1929 depression in part to

the resulting rigidity of the price structure. However that may be, the depression provided an occasion for a further entrenchment of vested interests and the process has been greatly accelerated during the present war. So far has it gone that a whole new literature has appeared dealing with the problems of monopoly. Control has passed in large measure to interested groups whose interests are by no means always closely identified with those of the public at large. It is not likely that the world will return, for a long time at least, to the former conditions of unplanned competitive enterprise. But unless the public realize the danger of placing their affairs in the hands of interested "pressure groups" the "brave new world" may produce less of solid benefits than the old. The need of the future is for enlightened and truly independent public control, so that interested groups shall be the servants and not the masters of the public. This will only be possible if a body of men with the necessary special training and experience can be formed, either to exercise the over-riding control of industry or to undertake the impartial investigation on which executive action should be based.

It is interesting to note that in Nyasaland control has been instituted without dispensing with the competitive system. This has been done by the establishment of central auctions held under Government auspices. Practically all the tobacco is disposed of in this way.

Among the more primitive peoples a few attempts at co-operative marketing have been made, but progress has been limited. In Nigeria and the Gold Coast some co-operative societies of cocoa growers are in existence, and the West African Cocoa Commission proposed a large extension of the system. Similar efforts have been made in certain other Colonies but they have not been very successful on the whole. Among the primitive peoples the societies cannot be left to run themselves and even careful supervision by a registrar is inadequate. The only type of organization with any promise, at least on a short-term view, appears to be that exemplified by the Kilimanjaro Native Co-operative Union, in which the general direction is entrusted to a competent European manager. The term co-operation can be used only in a limited sense in relation to this type. It is veering round very close to government marketing.

The need for further study of the actual processes of marketing is mentioned in the article under review. Indeed, very little in the way of properly planned economic study has been undertaken in the Colonies. The Colonial Service has remained aloof from developments in the Home country, the Dominions, the U.S.A. and other countries, where since 1918 almost all agricultural departments have incorporated sections dealing with agricultural economics. The field of investigation covers the economics of production and of marketing, including land tenure and co-operation. In the Colonial Agricultural Service there are very few posts requiring training in economics. Most of the literature on Colonial economics emanates from technical officers and mixed committees. With the terminology used critical analysis is impossible, fallacies are liable to creep in and the conclusions have a certain empirical flavour.

V. LIVERSAGE.

A RECONNAISSANCE SURVEY OF THE SOILS OF BRITISH HONDURAS, by Cecil F. Charter (Government Printer, Trinidad, 1940).

British Honduras is situated in Central America between Mexico, Guatemala and the Caribbean Sea. It is about a tenth part of Uganda in extent and carries a sparse population. The climate is warm with a rainfall ranging from 50 to 100 inches which, over the greater part of the Colony, is divisible into well-marked wet and dry seasons. Though there are extensive areas of apparently suitable soils and climate most of the land is still carrying virgin forest and there has been very little agricultural development.

The method of soil classification adopted by the author is an adaptation of the system that has long been in use in the United States of America. Account is taken of the parent material, mode of formation, topography, drainage and the morphology and base status of the natural soil profile. Soils which have been developed from the same or similar lithological materials under similar conditions and have developed essentially similar profile characteristics are classified as belonging to the same Soil Suite: such suites are christened with specific locality names so as to establish their individuality. Certain of the Soil Suites are divided into named Soil Series according to certain variations shown by the natural soil profile. This system of classification has further divisions into Soil Types which are given the Series name qualified by the texture of the soil profile, with special stress on the texture of the surface soil. The Soil Types are further sub-divided into Phases of the named Soil Types so as to allow for certain variations of slope, stoniness, depth, slight differences in

drainage and the potential fertility of the surface soil. In this system the soil is classified as a natural object on a scientific basis without much weight being given to the cropping performance of the land. The reader of this Journal will appreciate that the final subdivision into these Phases of the Soil Type often plays a dominant role in the use that a farmer can make of the lands at his disposal, but the earlier main classification offers a sound system for universal soil classification and the Soil Suites can be grouped together into Fascs, Groups and Divisions on the basis of similar base status, parallel profile development, drainage and soil site or regional topography.

In the areas visited, the author has identified and allotted names to about thirty Soil Suites and about twice as many Soil Series. He has given simple but clear descriptions of the make-up of the Soil Suites and Series such that they can be identified by the layman. One great advantage of this type of soil classification and nomenclature is that other soil workers that follow can recognize the described soils wherever they occur. The soil chemist can investigate the special reactions and optimum treatments for common types of soil and this work with complementary field experiments makes it possible to offer the farmer sound advice on the necessary treatments of recognized soil conditions. In the course of time the names of the Soil Series find their way into the local farming language and the cultivator can be enabled to make the most suitable and economic use of his lands.

A start along these lines has been made in East Africa but the limited amount of field survey and the necessary fundamental soil work that has already been done rather tends to stress the vast scope of the work that lies ahead. The recent death of Mr. G. Milne, Soil Chemist at the East African Agricultural Research Station, has been a great loss to the science of pedology in these territories. Though Mr. Milne was prolific and lucid in writing up his researches on the morphology and classification of East African soils, yet, one feels that a great amount of useful knowledge based on long experience of local conditions was lost by his untimely death.

Some of the main features of Mr. Charter's work in British Honduras are the great amount of recorded data derived from a reconnaissance survey of only some six months' duration and the fact that this survey has been possible in view of the almost complete lack of any physical and chemical data on the soils described and classified. In fact, the published survey has been based on trained visual observations only and it will be necessary to qualify and extend the work at a later date by quantitative expressions for the soil conditions obtaining. Many of the unanswered questions arising out of this survey could probably have been answered by a very limited amount of appropriate laboratory investigations. Furthermore, the recommendations of certain areas for agricultural development would carry more authority if the report had been accompanied by a favourable quantitative account of the potential fertility of the soils referred to. The survey adds much to the fund of soil knowledge that is already relatively well advanced in this region of the British Empire.

G. H. Gethin Jones.

Tea, Rubber and Cinchona Research

The fate of our scientific colleagues in Java is a matter of grave concern for us for nowhere else in the tropics has agricultural research made greater strides than it has under the able research workers of the Netherlands Indies. One of the last accounts of their work to appear in English is published in the *Empire Journal of Experimental Agriculture*, Vol. X, No. 7, where Dr. Ch. Coster, Director of the West Java Research Institute, Buitenzorg, describes the admirable work carried on there from 1938 to 1941. This institute, like several others of its kind in Java, is supported and managed by private enterprise, an arrangement that has certain advantages, as well as distinct drawbacks. The importance of the institute can be judged by the fact that it served the tea plantations (138,000 hectares) and the cinchona cultivations (17,000 hectares) of the Netherlands Indies as well as 160,000 hectares of rubber plantations in west Java and south and west Sumatra. The provision made by the Dutch for research on these crops has been on a truly grand scale compared with that spent on our major crops in East Africa; moreover the work has been steadily pursued since the beginning of the century. A notable feature of the research work carried out by the Dutch has been the full use made of trained native workers, a policy which relieves senior workers of much of the routine side of research and results in a high output of scientific work.

Tea.—A brief account of the investigations with this crop is given which should be of

real interest to East African growers. Botanical investigations were concerned with the anatomy of the tea plant, particularly leaf formation; deficiency symptoms (nitrogen, sulphate, phosphate, magnesium, calcium and potash); vegetative reproduction; and hand-pollination for seed production. Selection work dates from 1915 and the standard set is high, i.e. a minimum yield of 50 gms. of green leaf per plucking (5 or 6 per year); a yield at least three times that of the original material including a number of mother-trees amounting to not more than 1 per cent thereof. In this way clones were selected which yielded 100 per cent more than ordinary nursery stock; moreover it has been shown that seedlings raised from high-yielding clones give greater yields than ordinary seedlings.

In the account of fertilizer experiments it is interesting to note that sulphur appreciably increases the growth and production of bushes. It is not stated whether tea yellows occurs, a "disease" which caused great concern in Nyasaland until the work of Storey and Leach solved the problem by showing that the condition was caused by deficiency of available sulphur in the soil. A large number of fertilizer trials has made it possible to classify the west Javan tea soils according to their fertilizer requirements. The normal optimum fertilizer application for fully grown tea gardens is given as 300–500 kgs. of sulphate of ammonia and 100 kgs. of double superphosphate per hectare per annum (= 2.4–4.0 and 0.8 cwt. per acre respectively).

The most serious insect pest of tea in Java is *Helopeltis* which is now successfully and economically controlled by the use of derris powder.

Rubber.—The section dealing with preparation is of current interest to East African producers. Considerable progress has taken place in Java in recent years in the development of "tunnel" smoking- and drying-sheds which by improved insulation and air circulation reduce the drying time for crêpe. It has been shown that wet sheets can be completely smoked in a few hours and afterwards rapidly dried so that the total time for smoking and drying can be compressed into two days. Rubber moulds are prevented by disinfectants, especially paranitrophenol, but a better way is to keep the relative humidity of the atmosphere in the packing-shed below 70 per cent. Packing has also been investigated and gunny or other sheets found to be an adequate and cheap substitute for the usual 3-ply boxes which are costly and unnecessary.

Reference to a method of making a coagulant by a bacteriological process from latex serum and spirit is of particular interest. Coagulation with sulphonated oil has also been shown possible.

The section on tapping and the problem of raising the production of old rubber plantations to modern standards suggests that Hevea yields might be increased in East Africa by similar means. Experiments with the "two-cut" tap (one made 60–80 cms. above the other) and with the "high" tap (with a second cut at 2–3 metres height) indicate that yield-increases of 20–40 per cent can be obtained for several years by these methods. Other methods are also described.

Cinchona.—Analyses of bark have shown that the quinine content fluctuates throughout the year. In the early years the quinine-content of clones increases but on unmanured plantations a decline sets in about the fifth to seventh year. Manuring was shown to maintain the quinine-content or reduce the rate of decline. The quinine-content of the same seedling variety or clone varies according to soil and environment. A high content is found where vertical growth is stunted, as where *Helopeltis* attacks are common. By selection the original low quinine-content of Java cinchona has been raised to 12–15 per cent while some selections (clones) contain 17–18 per cent. Productive capacity has been doubled or trebled. Reference is made to a method for determining the quinine-content of standing trees from small (2 grm.) samples of bark (obtained with a punch) but, unfortunately, no details are given.

As in the case of tea, derris powder has proved successful in the control of the major insect pests of cinchona, *Helopeltis* and *Pachypeltis.*

The article ends with a valuable list of references, most of them from the *Archiev voor de Theeculture* and *De Bergcultures.*

A. G. H.

GAS PRODUCERS FOR MOTOR VEHICLES AND THEIR OPERATION WITH FOREST FUELS, by I. Kissin (Technical Communication No. 1, Imperial Forestry Bureau, 1942).

The possible use of producer gas as a fuel for motor vehicles has been given considerable attention for many months past in the East African territories by both the military and civil authorities, and with the need to conserve diesel oil and petrol a fresh impetus has been given to the consideration of this subject.

Several producer gas models have been experimented with here in fact in recent months, such as the Svedlund, South African Fuel Research Institute, and Ngata plants, but no wholesale adoption of them is yet in evidence.

In his monograph under reference the author presents a careful review of the factors influencing the use of producer gas in internal combustion engines and he is to be congratulated on having summarized them so ably.

Apart from his excellent theoretical summary, Mr. Kissin has given us some interesting data on which to cogitate. For instance, he states that in July, 1941, there were 180,000 vehicles propelled by producer gas in Germany and German-occupied Europe, whilst in Sweden in the same month over 90 per cent of the Swedish motor traffic was similarly propelled. Truly it can be said that "Necessity is the mother of invention".

The author discusses fully the more popular types of plants on the market, such as the Powell, Koela, Gohin-Poulenc, and Brandt models. Although these differ in mechanical design and operation in many respects, essentially they are all composed of a gas generator, a cleaning and cooling apparatus, and a mixing valve. Mild steel is the principal material employed in the manufacture of the equipment.

Among the interesting facts also given by the author are the following:—

(1) The weight of a producer plant excluding fuel is generally less than 15 lb. per H.P.

(2) The typical price of a good producer unit fitted to a lorry or car is about £100 in Britain.

(3) The high proportion of non-combustible gases (mostly inert nitrogen) in the producer-gas mixture results in a lower power output of the engine than that given by petrol to the extent of between 35 and 50 per cent. This loss can be reduced by raising the compression ratio of the engine, increasing the cylinder capacity or both.

As a rule the compression ratio is increased to between 7.1 and 8.1.

(4) As a rough guide one cwt. of charcoal may be taken as the equivalent of eight gallons of petrol.

The charcoal must be clean and have a low ash content. It must also be dry.

(5) Using producer gas vehicles can be run at about half the cost of petrol, or even lower.

There can be no doubt that the use of producer gas for driving motor vehicles is rapidly increasing in spite of the disadvantages inherent in producer-gas operation, chief among which are the initial cost of the equipment, its bulk and weight, the attendant loss of power and decreased flexibility of operation, and the extra labour and skill required.

Note.—In these territories there are several workshops capable of manufacturing producer-gas units for standard makes of vehicles and designs of several plants are available. It but remains for the authorities concerned to assess the general position as regards the maintenance of oil and petrol stocks *vis-à-vis* the availability of producer-gas plants in an emergency. The latter could be manufactured here fairly rapidly if necessary.

I would advocate in any case that every leading workshop throughout the territories should be asked by Governments to fabricate one standard model of producer-gas unit.

A. J. P.

PERADENIYA MANUALS NO. IV: DISEASES OF VILLAGE CROPS IN CEYLON, by Malcolm Park, A.R.C.S. (Lond.), and M. Fernando, Ph.D., B.Sc., D.I.C. (Government Press, Colombo, 1941).

During recent years the specialist in plant pathology has been increasingly catered for by the publication of advanced and exhaustive text books on the pathology of the more important tropical economic crops. Of these may be mentioned Petch's *Diseases and Pests of the Rubber Tree*, and *Diseases of the Tea Bush*; Wardlaw's *Diseases of the Banana* and Briton-Jones's *Diseases and Curing of Cacao*. Few books have been published written for the layman and planter and dealing with the crops of specific countries. Butler's *Fungi and Disease in Plants* and Nowell's *Diseases of Crop Plants in the Lesser Antilles* are standard text books of an advanced type and hardly suit the needs of the general agriculturist. Farmers in Queensland are admirably catered for by the excellent handbook by Simmonds (*Queensland Plant Diseases and their Control*, G.P., Brisbane, 1938) but in most Empire countries the need for such a book has yet to be filled. With *Diseases of Village Crops in Ceylon* the authors have provided one more agricultural community with an admirable handbook. In this book of some 70 pages the authors have presented the general principles of plant pathology and their special application to Ceylon

in a form for which the Ceylon agriculturist and student will have much cause to be grateful.

In Part I there is a general discussion on plant disease with an introductory account of the structure of fungi, parasitism and symptoms of disease.

Part II, which perhaps from the point of view of the student is the most important section of the book, deals in considerable detail with the various types of disease and the control measures appropriate to each. Of the soil-borne diseases the examples chosen are the *Fomes* disease of rubber, the Bacterial Wilt of Solanaceous crops, Sclerotial diseases and the Root Eelworm. In the control of the two latter diseases the importance of heavy dressings of organic matter is stressed. It is also pointed out that most of the measures recommended are those which should be practised by the good agriculturist and that "good husbandry and the prevention of plant diseases often go hand in hand".

The Pink disease of trees (*Corticium salmonicolor*) is the example chosen of a stem disease. In this section, too, is an account of decay and die-back of branches and modern methods of tree surgery to prevent and to deal with them. The section concludes with a description of three typical leaf diseases: the *Cercospora* disease of tobacco, powdery mildew of citrus, and the bacterial leaf spot of Betel.

In Part III notes are given on diseases of over fifty crop plants. Some, of particular importance to Ceylon, are treated in detail. Such are Citrus Canker (*Pseudomonas citri*), a very serious menace to citrus cultivation in Ceylon, diseases of the coco-nut and rice. Two serious diseases of the banana, Panama disease and Bunchy Top, are very fully described and illustrated.

Part IV is a thoroughly up-to-date and practical treatise on the principles of plant protection and the preparation and use of copper and sulphur spray fluids. Detailed instructions are given for the preparation of copper emulsion, which is claimed to have certain advantages over Bordeaux, especially in a country where good lime is difficult to obtain. The use of dusts and the value of wetters and spreaders are also included, together with a detailed description of the types of apparatus, available to the small farmer, from a Flit gun to a Headland pump. The two examples of seed disinfection described are the silver nitrate treatment of tobacco seed and the use of corrosive sublimate for the treatment of seed ginger against sclerotial diseases. Seed disinfection of cereal and other seeds with copper and mercurial dusts is apparently not practised to any extent in Ceylon. For general seed disinfection corrosive sublimate is used, a chemical one would hesitate to recommend to less enlightened village communities.

In the section on soil disinfection mention is made of the important part tropical sunshine probably plays in the action of a bare fallow. East African readers should note this as they are fortunate in having an abundance of this excellent commodity at their disposal.

The book is generously illustrated with thirty-two excellent plates in colour, half-tone and line block. On reading in the preface that the book is one of a series intended for use in schools one can but admire the standard of education which these schools must have achieved. All interested in agriculture, student, farmer and specialist alike, will read the book with interest and profit.

R. M. N.

TESTING ONION AND LEEK SEEDS BEFORE PLANTING

Onion seed loses its vitality very quickly, and care must therefore be taken to purchase good reliable seed. Seeds can be tested quickly and easily by the following method:—

Wrap 100 seeds in a piece of new flannel. Place into *boiling* water for 20 minutes. Remove the packet and examine the seeds. An approximate estimate of the percentage of germination can be obtained from the number of seeds which have burst their seed-coats. Under ordinary conditions, an onion seed takes from 12 to 21 days to germinate.

J. G. King, Agricultural Officer, Moshi.

AGRICULTURAL EXPERIMENTATION

The certainty of the results really depends on three faculties in the experimenter. Firstly, there is common sense, which counts for a lot. Secondly, a critical or fault-finding nature is invaluable. Thirdly, the experimenter needs knowledge of all the other things that may make plants grow better or worse. Farmers are just as likely to have the gifts of common sense and criticism as scientists, and although they may not be so well versed on the chemical side of the experiments, they are likely on the average to know better what nasty little things might be interfering.

Michael Graham in *Soil and Sense*.

NICOTINE

(Extract from "Nicotine, a product of tobacco", by G. M. Ward, Dominion of Canada—Dept. Agr. Tech. Bull. 38, Decr. 1941)

The Manufacture of Nicotine Products

In the manufacture of nicotine almost any type of tobacco or tobacco waste may be used as the original stock. The leaves of the general run of stock employed by commercial companies contain on the average 2 to 4 per cent of nicotine and the stems 1 per cent. The higher the nicotine content of the original stock, the higher will be the nicotine content of the extract. Special varieties of tobacco containing up to 10 per cent nicotine may be employed, but it appears that the production of this type of tobacco for the sole purpose of nicotine extraction is not profitable on account of the low price which nicotine manufacturers are able to pay for their original stock. For this reason it is more economical for them to purchase tobacco waste or stems from factories or farmers engaged in the production and manufacture of smoking tobacco.

The details of the commercial methods for extracting nicotine are likely to vary with the individual manufacturing plant. Futhermore, individual private companies are likely to have certain details incorporated into the processes they employ which are not available as general knowledge or which, if they are known, are protected by patent rights. All procedures, however, are based on one of three principles or a combination of these. The first and most widely used method depends on the solubility of nicotine in water; the second method is the extraction of nicotine with organic solvents; and by the third method, nicotine is released by the use of an alkali and then steam distilled. In all cases the initial stage of extraction is relatively free from difficulties. However, certain problems arise in connexion with the subsequent operations of concentration and purification of the extract. These are usually long tedious processes and involve the use of special expensive apparatus.

Home-made extracts and nicotine sprays are usually made by the water extraction process, and the following set of instructions is adapted for such use. It is recommended that the tobacco stock (stems or leaves) be used at the rate of one pound to one gallon of water. Various procedures may be followed such as cooking with live steam, cooking in an open kettle, or soaking the stems in cold water. Water at ordinary temperatures extracts 75 to 90 per cent of the nicotine—the first extraction yielding the greatest amount, successive extractions removing the remainder. Warm water gives a better extraction than cold and shortens the time of extraction, but it may cause a considerable loss of nicotine due to volatilization. For this reason the temperature should not be raised above 60° C. (140° F.).

If cold water is to be used, a practical method is to put the stock into a kettle or barrel, add the required amount of water, and allow to soak for 24–48 hours with occasional agitation. If heat is to be used, place the stock in an iron kettle or similar receptacle, and cook just below boiling for about two hours. After the cooking or soaking, drain off the liquid and press the residue. From a mixture of 30 pounds of tobacco stock and 30 gallons of water about 25 gallons of extract solution may be obtained. This extract will contain approximately .05 per cent of nicotine. The solution is of sufficient strength to kill plant lice and may be used without any further dilution for that purpose. However, if it is kept for several days it is liable to ferment with consequent loss of nicotine unless a small amount of some preservative such as formalin, toluene or glycerine is added.

A water extraction may also be made in the presence of a dilute acid, but this procedure is not so satisfactory as the above method.

After concentration and purification, the final commercial product usually contains approximately 40 per cent of nicotine in the form of nicotine sulphate.

The Uses of Nicotine

The poisonous nature of nicotine and its use as an insecticide have been known for many years. A book on the history of tobacco published in 1859 gives an account of the use of a tobacco extract for killing bugs in a kitchen garden. To-day it serves a number of different purposes. It is used for killing insects such as aphids, bud-moths, leafhoppers, etc., in orchards; for killing poultry lice and feather mites; as a drench for killing stomach worms in sheep; as a dip for killing lice on live stock, also sheep tick; as a contact insecticide it controls sucking insects on garden vegetables; it is used to prevent staining of shrubbery and evergreens by dogs; it is used as a control for

insect pests which attack flowers, vegetables, and canning crops; and finally it is used for fumigating greenhouses.

Nicotine solutions, either in the fixed state as sulphate or in the free state as the pure alkaloid (nico-fume) are used universally in the control of orchard and garden pests. In the orchard spray programme nicotine solutions are an ingredient of the tank spray mixture when sucking or soft-bodied insects are to be controlled. It is seldom that nicotine solutions are applied alone in the orchard, though this does occur when aphids appear late in the season and it is necessary to exterminate them. Nicotine dusts containing 2 per cent actual nicotine alkaloid are frequently applied when it is necessary to wipe out a local and severe infestation of insects such as leaf-rollers or bud-moths. When nicotine is used in spray form the concentration may vary from $\frac{1}{4}$ of a pint to 1 pint in 100 gallons of spray for ordinary use; for very severe infestations one quart in 100 gallons should be used. When applications are made in "dry spraying" then dust mixtures are prepared containing 2 to 5 per cent of actual nicotine as alkaloid. In table 1 the formulae are given for the quantities of nicotine sulphate to be added to varying spray mixtures, and also the quantities necessary to prepare the specified dust mixtures. The smaller quantities are suitable for small plot work, or for spraying or dusting shrubs and flowering plants. The larger quantities are adaptable for large scale operations.

There are many different types of dusting and spraying apparatus ranging all the way from an ordinary watering can and knapsack duster to the horse-drawn or motorized type of equipment. The type of machine used will depend on the quantity of material to be applied and on the economic aspects of the orchard. For most immediate results spraying or dusting with nicotine should be done during the hottest part of a calm day. Use plenty of material and pay special attention to the undersides of the leaves. Nicotine sulphate does not burn foliage and can be safely mixed with combination sprays containing arsenicals and fungicides.

TABLE I—NICOTINE SPRAY

Water	1 gallon	5 gallons	20 gallons	40 gallons
$\frac{1}{4}$ pt.-100 gal.	$1\frac{1}{5}$ teasp. 1 oz. soap	6 teasp. $\frac{1}{4}$ lb. soap	3 oz. 1 lb. soap	6 oz. 2 lb. soap
1 pt.-100 gal.	$1\frac{1}{5}$ teasp. 1 oz. soap	8 teasp. $\frac{1}{4}$ lb. soap	4 oz. 1 lb. soap	8 oz. 2 lb. soap
$1\frac{1}{4}$ pt.-100 gal.	$2\frac{2}{5}$ teasp. 1 oz. soap	12 teasp. $\frac{1}{4}$ lb. soap	6 oz. 1 lb. soap	12 oz. 2 lb. soap

NICOTINE DUST

Hydrated Lime	5 pounds	25 pounds	50 pounds	100 pounds
Approx. 3 per cent dust	6 oz.	$1\frac{7}{8}$ lb.	$3\frac{3}{4}$ lb.	$7\frac{1}{4}$ lb.
Approx. 5 per cent dust	$9\frac{1}{2}$ oz.	$3\frac{1}{8}$ lb.	$6\frac{1}{2}$ lb.	$12\frac{1}{8}$ lb.

When nicotine is used for delousing poultry, the concentrated 40 per cent solution is painted on the roosts in a very thin coating, the fumes being released by the body heat of the birds when roosting. Good ventilation is absolutely necessary in this case and the manufacturer's directions should be closely followed. "Black Leaf" worm powder is also used to rid poultry of the large roundworm.

PURSUIT OF NATURAL SCIENCE

The pursuit of natural science may be regarded as a type or microcosm of all rational life. For, first, scientific work employs reason working upon sensible experience; it requires careful seeking of evidence, and constructive interpretation thereof; and consequently demands respect for fact, for logic, for insight and for imagination. Second, it exhibits a rational unity of thought and action, in the continual interplay of experiment and theory. Third, it is a social as well as a personal enterprise; as such, it demands respect for the human person and tolerance for diverse opinions, and favours a mental climate which is a balance of appreciation and criticism.

E. F. Galdin in *Nature*.

It has been well said that the secret of happiness is to be interested. It might have been added that one essential for happiness is to be disinterested. English is a language full of surprises.

The poverty and fragility of the soils have been one of the principal causes of disillusionment experienced by white settlers in the tropics, and the problem becomes greater as the products of these regions enter more largely into our material civilization.

Jean Gottman in *Geographical Review*.

STORAGE OF VEGETABLE SEEDS*

There is a marked paucity of information on the subject of practical methods of storage of vegetable seeds in the tropics. It is known that vegetable seeds, especially those imported from temperate climates, lose their viability very rapidly. An article on this subject recently published in *The Philippine Journal of Agriculture* throws more light on the subject and presents a practical method for storage of seed under tropical conditions.

Previous work by other investigators showed that insect attack, high temperature and high moisture were limiting factors affecting the life of the seed. Seed will endure high moisture if the temperature is low, and comparatively high temperatures if the moisture is low. Other investigators proved that seed stored in sealed containers with and without naphthalene remained strongly viable from two to four years, while those in cloth bags lost their viability in less than a year, with a few exceptions. It has also been shown that moisture exerted more influence on the viability of seeds than temperature.

In these most recent experiments ten different kinds of vegetable seeds were used, viz.: Surehead cabbage, *Brassica oleracea* var. *capitata* L.; Early Patna cauliflower, *Brassica oleracea* var. *botrytis* L.; Chinese pechay, *Brassica cernua* Tumb.; Chinese long radish, *Rhaphanus sativus* L., Big Boston lettuce, *Lactuca sativa* L.; Yellow Bermuda onion, *Allium cepa* L.; Japanese purple egg-plant, *Solanum melongena* L.; Bontoe pepper, *Capsicum frutescens;* Mary Washington asparagus, *Asparagus officinalis* L.; and cucumber, *Cucumis sativus* L. With the exception of the asparagus, egg-plant and pepper, which were produced locally, no information was available regarding the age of the other seeds which were imported. It was assumed that they were comparatively new.

Seeds before storage were thoroughly dried at a temperature ranging from 45° to 50° C. for about two days, as were also the storage receptacles, and the seed was placed in the storage vials while still warm. Two conditions of storage were employed, viz. sealed and unsealed vials. Thus the seeds were stored (1) under airtight conditions and (2) under the influence of air and its relative humidity.

Seeds stored in corked but unsealed containers lost their viability within a comparatively short period. For example, the cabbage and lettuce seeds began to be critical in their viability in 3 to 4 months respectively after storage; cauliflower and cucumber in 6 and 5 months respectively; pepper in 6 months; onion in 8 months; radish in 10 months; pechay in 10 months, and egg-plant and asparagus in 13 and 14 months respectively. The deterioration of seeds in the corked but unsealed containers was rapid after their viability became apparently critical. The cabbage completely lost its viability after 6 months, cauliflower in 11 months, cucumber in 13 months, pepper in 17 months, onion in 13 months, lettuce in 8 months, radish in 18 months, asparagus, egg-plant and pechay in 21 months. In this connexion it may be stated that a corked vial is a better storing receptacle than either cloth or paper bag, the usual containers.

The different seeds that were kept in corked and sealed containers kept their viability much longer than their counterparts which were kept in corked but unsealed containers. The following are the critical periods, in months: radish 21, cauliflower 37, cabbage 23, pechay 41, lettuce 17, cucumber 17, onion 15, asparagus 38, egg-plant 28, pepper 41, while at this time pechay was still strongly viable and pepper was still giving a fair viability.

The range of longevity of the seeds in the corked and sealed containers varied from 27 months to over 41 months. The lettuce seeds completely lost their viability after 27 months in storage, cabbage after 36 months, onion after 38 months, cauliflower, radish and cucumber after 39 months, asparagus after 40 months. Egg-plant, pechay and pepper were still germinating after 41 months in storage.

It was noted that there was a temporary rise in the percentage of germination of most of the seeds after they had shown some signs of weakness in their germination.

* *Philippine J. Agric.*, Vol. 11 (4), 1940, as abstracted in *Malayan Agric. J.*, Vol. 29 (5), 1941.

THE SCIENTIST'S ENGLISH*

"At places these soils have been developed under heavy rainfall and in other localities under very low rainfall, but usually in both instances under relatively high temperature conditions."

The writer of this sentence is trying to say that temperatures are uniformly high (he might have told us how high) and that rainfall ranges from heavy to very light. This outrage on our naturally lucid language will serve as my frontispiece.

The purpose of this article is to make the reader more conscious of the bad writing of much of our scientific work, and to suggest that we should do something about it. We scientific workers are justly proud of having made things clear that were mysterious; it would be excellent if we could also be proud of our clear writing, and I do not see why we should not avoid some of the bad English of our day. Naturally, anyone feels diffident about discussing these matters in print, for fear of seeming to claim some stylistic virtue oneself. I make no such claim. But as a reader of masses of other people's work, I am concerned at the obscurity and pomposity which beset us and which make my own task more difficult.

We all learn the elementary rules of grammar at school. But only a few of us go further and learn to avoid other vices which are just as bad as grammatical mistakes. The only "advanced" rule which everybody knows is that you must not split an infinitive. But a little chink in an infinitive is really not so great a crime, and the most resounding infinitive that has ever been split does not cry to heaven like that "conditions" at the end of my frontispiece.

I have mentioned obscurity and pomposity as the two enemies. Obscurity is of course the real villain; pompous expressions are bad because they are difficult to take in—we have to spend time in translating them into the mother tongue. Yet some teachers train their pupils to be pompous, to use a long word of Latin or Greek origin where a short English word would do, to use abstract nouns instead of simple statements. Australian scientific literature teems with examples. When a man produces a better strain of a plant, he writes about "achieving amelioration of quality". If insects are likely to damage a crop, then "production will be hampered by entomological problems".

This is the vice which Fowler in *Modern English Usage* neatly labels "Genteelism". The editor of the Geological Survey of U.S.A. in his pamphlet *Suggestions to Authors* writes as follows: "Some members of the Geological Survey never go anywhere—they invariably 'proceed'. Neither do they 'begin' work; they 'inaugurate' or 'initiate' it. (In Australia, of course, they 'commence' it.) Nor do they 'get' or 'obtain' information; they 'secure' it." This refusal to use the proper word seems to me to be due to shyness. It is somehow not quite nice either to "lend" or to "give" someone a shilling; it is nicer to "loan" it or to "donate" it. To say that the rock is dark green is too frank. A timid writer feels impelled to say it is "dark green in colour", though I cannot imagine what else a rock could be dark green in. Such mincing manners are not worthy of educated men and women.

A serious menace in the scientist's English is the noun-as-adjective. Now we cannot do without this device (*Government* subsidy, *fume* cupboard, *room* temperature), but it has been carried to disastrous lengths in recent years, largely through the influence of newspaper headlines, which consist of little else than nouns. The defender of these headlines may say that their curious English is necessary in order to save space. No doubt one can excuse some of their faults on this account, but the excuse does not hold for ordinary writing. Nor does it always hold for headlines; for example, "Thai-French Dispute Settlement" was the headline over an announcement that this dispute had been settled. The use of "settlement" instead of "settled" has made the heading longer and absurdly ambiguous.

Innumerable sentences are made obscure by long strings of nouns. "Until the advent of the *hybrid programme maize improvement methods* were based essentially on selection." After a moment of bewilderment we may solve the puzzle. Only the second and fifth of these nouns have their normal status. *Maize* and *improvement* have to be said as one word, and the pair of them describe the *methods*. The reader is checked and irritated by such a sentence, and is in a less receptive mood for what follows.

* By G. W. Leeper, M.Sc., School of Agriculture, University of Melbourne. Reprinted from *Aust. Journ. Sci.*, Vol. 3, No. 5, 21st April, 1941; pp. 121-123.

The position is made far worse by the decline of the hyphen. Typists seem to dislike hyphens, and editors and printers often fail to restore them where they would redeem a string of nouns. The sentence "only two third generation seeds were selected" is a puzzle until a hyphen goes in after "third". Again, "Two grams of air dry soil" would no longer irritate if a hyphen made it clear that "air" is not a noun but an adverb. We sometimes snigger at the foreigner's *Laboratoriumsuntersuchungsprozesse*, but this word is far clearer than the above quotations.

Another cause of obscurity is the taboo against the use of the first person. I realize that there are reasons for this taboo; I have even applied it editorially. But it has helped the prevailing tendency to an obscure style, since it involves using the feeble passive voice and roundabout statements. Let me try putting these sentences into the language which I am protesting against: "It is recognized by the present writer that cogent arguments may be promulgated in favour of the principle of impersonal statement in articles of a scientific nature, but it is urged that the consequence of adherence to this formula is frequently a relatively unsatisfactory standard of reader comprehension."

It must surely be possible to train science students to appreciate a straightforward statement, in spite of false standards which they may have adopted from other sources. Here is an experiment which follows the lines of Biaggini in *The Teaching of English*. Take a sentence in bad scientist's English, try to recast it without its faults, and ask the class to choose between the two versions. Thus:—

(*a*) Prior to the advent of white men, soil formation was proceeding at an equivalent rate to soil denudation.

(*b*) Before white men arrived, soil was being formed as fast as it was denuded.

While the result of the first experiment may be disappointing, the comparison serves its purpose if the student realizes that the problem exists, and that not every writer "proceeds" from one abstract noun to another.

The American pamphlet referred to above, written for the Geological Survey, is admirable. It would be a great step forward if similar pamphlets could be written here, with their examples adapted for the various classes of scientific workers.

In conclusion, every man must have his own style, and some like long words more than others. But the scientific world may be divided into two groups: those who try to find things out and those who endeavour to ascertain them, and we of the first group spend far too much of our time trying to find out what those of the second group mean.

AN AFRICA RESEARCH COUNCIL

One of the suggestions made to the British Commonwealth Science Committee is that for the purposes of scientific research and development Africa might be treated as a separate unit, the work being a joint concern of the scientific organizations of the United Kingdom on the one hand and of the Union of South Africa on the other. Among the subjects to be treated, for which Africa as a whole has special needs and opportunities, might be tropical diseases, social anthropology and race relations, native languages, ethnology, geology, geophysics and meteorology.

The formation of an Africa Research Council, a joint interest of both of governments and private benefactors and individuals, as so many of the best of our British institutions are, might lead to developments of the kind required for specifically African problems. There is no other region in the world in which the same variety of researches is needed, all to some degree for geographical and political reasons inter-related; if the different elements of this variety could be treated each as part of the whole scientific problem of Africa, and made to fit into the other elements, the results might be much more satisfactory and more far-reaching in importance than if all were studied separately according to subject and locality. A good example of the need for such an Africa Research Council is shown by the failure, before the war, to get a badly needed geodetic survey of Africa started, because there was no body in existence to father it.

It is clear that a scheme of this kind must wait for better times: it would involve the setting up of a central office and council, the collection and allocation of funds, the distribution of work and interests between it and other agencies, and the foundation of new or the development of existing research institutes, in Great Britain or in various parts of Africa. In view, however, of the obvious advantages it might have, it may be well to throw it now into the arena of discussion, on one hand so that it may be thought about, on the other so that no action may be taken in the meantime which might make it in the future more difficult to realize.

Prof. A. V. Hill reported in *Nature*, 12-6-42.